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JUAN CARLOS LIN

A STUDY OF BRAZILIAN MANUFACTURING INDUSTRY: GREEN INNOVATION AND ITS IMPACT ON FINANCIAL PERFORMANCE

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Dissertação apresentada à Escola de Administração de Empresas de São Paulo, da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre em Administração Empresas.

Campo de conhecimento: Gestão de Operações, Sustentabilidade.

Orientador: Prof. Dr. Luiz Carlos Di Serio

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To my father and mother
For their endless support in my whole life

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RESUMO

O objetivo deste estudo é examinar a relação entre inovações ambientais implementadas por empresas da indústria manufatureira brasileira e seus impactos em suas performances financeiras. Esse exame pode afetar a escolha de recursos tecnológicos durante a competição no mercado, impactando gradualmente o desenvolvimento sustentável da sociedade. Procura-se responder à pergunta: Empresas manufatureiras do Brasil que escolhem inovação verde performam de maneira diferente de empresas que operam com estratégias de inovação tradicional? Neste estudo é utilizada regressão linear múltipla com dados empíricos, para mostrar o impacto no resultado financeiro de uso de inovações tecnológicas verdes. A evidência empírica é baseada na análise de 4.545 empresas, cujos dados foram coletados pelo Instituto Brasileiro de Geografia e Estatística (IBGE), da Pesquisa de Inovação Tecnológica (PINTEC) e da Pesquisa Industrial Anual (PIA), bem como de empresas brasileiras que tenham desenvolvido uma ou mais inovações, evidenciando seu impacto em Redução de Material (MR), Redução de Energia (ER), Redução de Água (WR) e Redução de Impacto Ambiental (resíduo e poluição) (EIR). Os dados englobam os anos de 2011 a 2014, focando em empresas que tenham desenvolvido e implementado uma ou mais inovações, mostrando seu impacto em WR, MT, ER e EIR e seu efeito em sua Performance Financeira Superior (SFP). SFP é um construto do estudo, que é composto de Crescimento de Receita Superior (SSG) e Rentabilidade Superior (SP). Foi realizada a estatística descritiva e análise da regressão, com o intuito de determinar a predominância de cada tipo de Inovação Verde (GI) na indústria manufatureira brasileira e como isso afeta a performance financeira. O resultado mostra que apenas inovação relacionada a WR apresenta correlação positiva com SSG, mas apenas nas empresas de controle de capital estrangeiro, e não em toda a indústria manufatureira. Isso mostra que a maioria das GI implementadas na indústria manufatureira brasileira carecem de eficiência. Outros tipos de GI não afetam a performance financeira, seja na indústria manufatureira como todo ou apenas em empresas com controle de capital estrangeiro. Este estudo busca contribuir com a literatura acadêmica de três seguintes maneiras: Primeiro, aprofundar o conhecimento de como inovações ambientais são associadas com a performance financeira. Segundo, demonstrar como a performance financeira é melhorado por inovações sucedidas. Terceiro, buscar contribuir, de modo prático, com uma visão clara de escolha tecnológica sustentável, levando a discussão ambiental para um nível estratégico nas organizações. E, por último, confirmar a importância de tecnologias ambientais, permitindo o esforço único entre o público e privado, para aprofundar o desenvolvimento sustentável.

Palavras-chave: Brasil, Vantagem competitiva, Performance Financeiro, Rentabilidade Superior, Crescimento de Receita Superior, Sustentabilidade Ambiental, Inovação Verde, Desenvolvimento Sustentável.

ABSTRACT

The aim of this study is to examine the links between developed environmental innovations and its impact on the financial performance of Brazilian manufacturing industries. This affects how firms choose their technological resources in market competition, and slowly affects society's sustainable development. It seeks answers to the question: Do Brazilian manufacturing firms that choose a green line of innovation perform financially different – compared to firms operating with conventional innovative strategies? Using multiple linear regression, from empirical data, it shows the impact of using innovative green technology on organizational financial results. The empirical evidence is based on the dataset gathered from 4545 Brazilian companies by Instituto Brasileiro de Geografia e Estatistica (IBGE) from the Pesquisa de Inovação Tecnologica (PINTEC) and the Pesquisa industrial Anual (PIA) survey. Brazilian firms which have developed one or more environmental or traditional innovations, evidencing its impact over material reduction(MR), energy reduction(ER) water reduction(WR) and environmental impact(waste and pollution) reduction(EIR). The data cover 3 years from 2011 to 2014 and focus on firms which have developed one or more innovations, showing its impact on WR, MT, ER and EIR and the effect on the Superior Financial Performance (SFP) of the firms. SFP is a composition of Superior Sales Growth(SSG) and Superior profitability(SP). Descriptive statistic and regression were perform with the intent to determinate first, the prevalence of each type of Green Innovation (GI), in the Brazilian manufacturing industry and second, how each affects financial performance. Result shows that only innovation related to WR have a positive relation with SSG (foreign controlled companies) but not in all manufacturing industry. Showing that most GI implemented by Brazilian manufacturing firm are inefficient. Other type of GI do not affect financial performance, in the manufacturing industry or in foreign controlled manufacturing companies. This study hopes to provide three contributions to academic literature. First, to deepen the existing knowledge of how environmental innovations are associated with financial performance. Second, to demonstrate how financial performance can be enhanced along successful innovation processes. Furthermore, the aim is to propose a practical contribution by giving a clearer roadmap of the sustainable technology choices, as well as bringing forth an environmental discussion about strategical choices. And last but not least, to confirm the importance of environmental technology, enabling a public and private united effort to further a sustainable development.

Keywords: Brazil. Competitive Advantage. Financial performance. Superior Profitability. Superior Sales growth. Environmental Sustainability. Green Innovation. Sustainable Development.

SUMMARY

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LIST OF ABBREVIATIONS

EIR	Environmental Impact Reduction
ER	Energy Reduction
GI	Green Innovation
IBGE	Instituto Brasileiro de Geografia e Estatística, Brazilian institute of Geografy and Statistic
MR	Material Reduction
OECD	Organization for Economic Co-operation and Development
PIA	Pesquisa Anual Industrial or Anual Industry Survey.
PINTEC	Pesquisa de Inovação Tecnológica, Technological innovation Survey.
R&D	Research and Development
RBV	Resource Based View
SFP	Superior Financial Performance
SP	Superior Profitability
SSG	Superior Sales Growth
WR	Water Reduction

1 INTRODUCTION

"There is no alternative to sustainable development" (PRAHALAD, 2009, p 57).

By 2050, the world will be hosting 9.7 billion people, according to the United Nations (UN, 2015), that is if the population growth slows down in most of the developing world. In 2009 there were at least 1 billion people chronically malnourished or starving. To simply maintain this current situation with the same productivity and food consumption rate, it would require 900 million additional hectares of land, but only 100 million hectares would be available, through deforestation. This example is only related to food constraint. If considering other resources needed due to population growth, the possible scenarios are mostly negative. Altogether, there is a clear view of the organizational challenges that companies will have to face in order to avoid climate changes and to be able to achieve a sustainable development of society securing the stable condition for future generations. This is why Prahalad (2009) states that sustainability is the next driver to innovation, and why it will be a mandatory organizational capacity in order to adapt in a resource constrained world.

Some researchers explain that Green Innovation (GI) generate competitive advantage through more efficient processes, improvements in productivity, lower costs and new market opportunities (HART, 1995; PORTER;VAN DER LINDER, 1995). Also consumers' environmentalism is increasing, and they are willing to pay relatively high prices for eco-friendly products (PORTER; VAN DER LINDE, 1995; HENRIQUES; SADORSKY, 1996) making green business more profitable to some extent. Previous empirical studies exploring the links between environmental innovations and competitive advantage measured by business performance have mainly reported about the linear positive relationship (RUSSO; FOUTS, 1997; CHEN., 2006; WAGNER, 2009).

Contrary to this, some researchers argue that despite the growing interest in green consumerism, consumers are not yet a driving force of environmental responsiveness (THOGERSEN, 2006; SANDHU et al., 2010). This is supported by Michaud and Llerena (2011), who found no evidence that consumers are willing to pay a premium price for green products. Some argue that this is an organizational mislead due to green marketing myopia, developing products that aim only to reduce environmental impact but not product improvement. Despite this, organizations are adapting fast, so the aim of this study is to show the current business environment.

According to Prahalad (2009) innovation driven by sustainability will produce sustainable competitive advantage in a changing climate scenario. This he concludes this from his several case studies of selected businesses, but there is still no clear study proving this relation at a larger scope in Brazil, showing how the financial performance of a company is affected by implementing GI. Nor a studies highlighting the differences of the financial performance of firms choosing a green line of innovation compared to firms operating with more conventional innovative strategies.

Another statement of Prahalad (2004) also shows that innovation traditionally is initiated as an internal effort, but to achieve a better result, collaboration within the industries or with firms from other industries should also be considered.

This study will help top managers from different businesses, to see the impact of their technological resource aiming, to contribute to an organizational competitive advantage strategy, and to indirectly contribute to a social adaptation in an environmental constrained scenario, by creating a "sustainable" knowledge.

The main objective is to measure how GI is affecting the current superior financial performance (SFP), throughout Brazilian industries. The second objective is to investigate current innovation theories in order to see whether they can be applied when discussing GI.

First the main question: Do Brazilian manufacturing firms that choose a green line of innovation perform financially different – compared to firms operating with conventional innovative strategies?

Then as a secondary question; which type of Green Innovation impact (material/energy/water/pollution) reflects on the financial performance?

The study is structured in the following way:

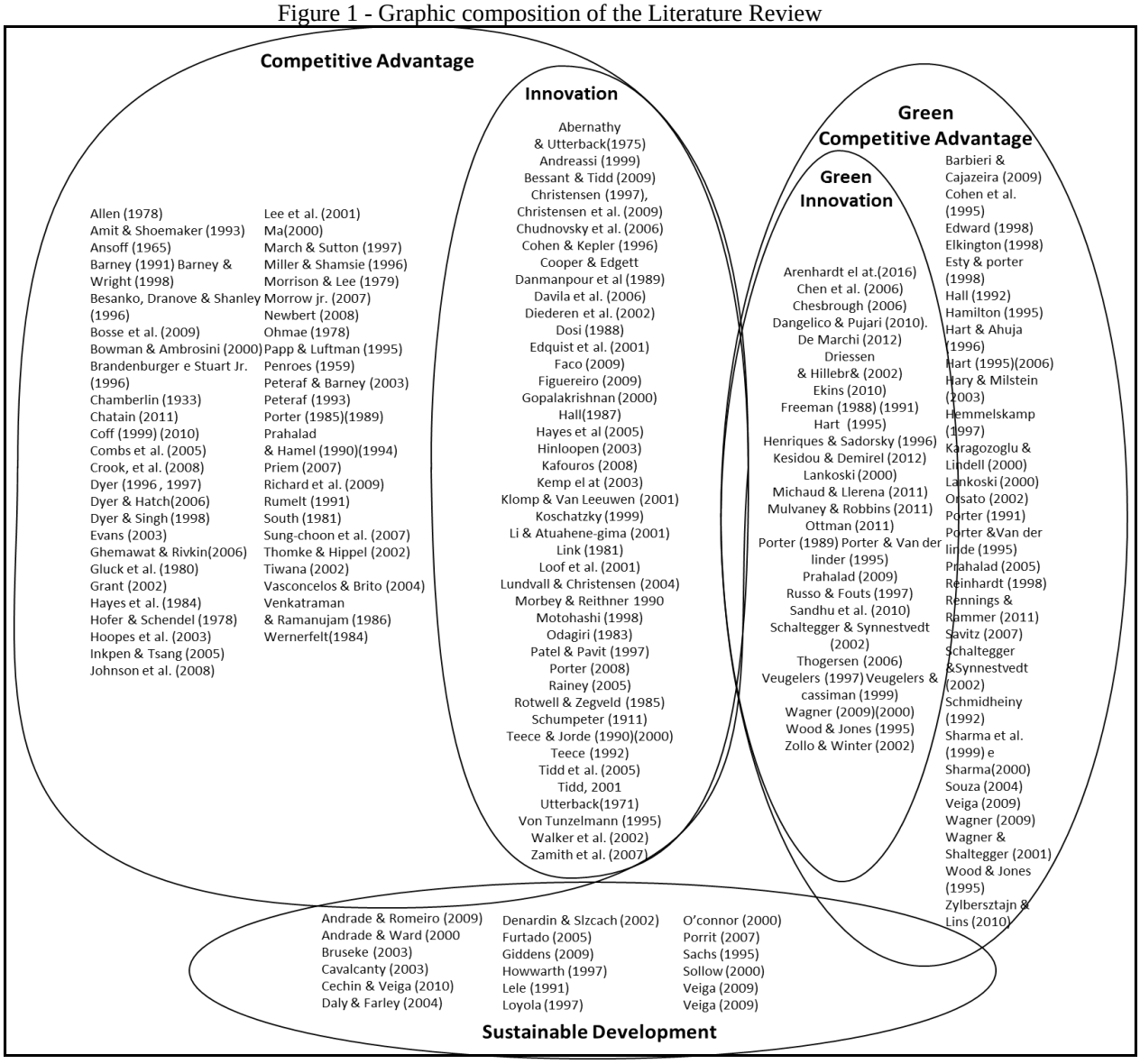
a) literature review: showing chronologically, how the discussion of the competitive advantages of sustainability developed;
b) methodology: a description of the method of analysis showing the established hypothesis and the variables needed for this process explained in the previous section;
c) results: an analysis of the results, based on general and specific industries, and will check the hypothesis test status, compare data in order to see the difference and similarities in different industries and also compare these results to the main theory;

d) conclusions: a final conclusion of the study, summarizing the results found, Outlining the applicability of this study, and looking to understand the limitations of the methods, the sample sizes and other limitations.

2 LITERATURE REVIEW

This chapter will present the structure of the literature review, beginning with a competitive advantage discussion as to introduce the main theories as the base of this study. Secondly a sustainability development discussion will be put forth in order to understand the social transformation and its impact. And lastly there will a main discussion covering the topics of green competitiveness and GI.

Figure 1 - Graphic composition of the Literature Review



Source: Self elaboration (2017)

2.1 Competitive advantage

The modern business management strategy was developed at the beginning of the last century, gaining gradual attention after the industrial revolution, due to the industrial mass production that intensified business competition. Since then organizations have been focusing more and more on how businesses can survive or even outperform others. The competitive advantage strategy has thus been one of the most studied subjects due to this organizational concern, The first definition of a competitive advantage, was described as the possibility of a business to outperform its competitors. This was first presented in the monopolistic competition model by Chamberlin (1933). Later Ansoff (1965) referred to it as an advantage in a “positional competition", obtained by adjusting the products to the market. Around 1970, during the Japanese industrial success and its impact on other markets, the competitiveness discussion gained even more relevance, and the concept of “competitive advantage” appeared in several publications. However when mentioned the focus was still mainly on the competitive position part and without a precise definition (ALLEN.1978;MORRISON; LEE, 1979; OHMAE, 1978). In the 80´es, the name “competitive advantage” became used more frequently, bringing forth deeper analyses regarding competitiveness, and that was the reason why some companies were performing better than others. (GLUCK et al., 1980; HAYES et al., 1984; SOUTH, 1981). However the main event, that transformed the name competitive advantage to a whole new level was the publication of Michael Porter’s (1985), competitive advantage. After this the concept gained a current generical meaning of being associated to an undefined concept of value (BARNEY, 1991; PORTER,1985) and often related to a SFP (AMIT; SHOEMAKER. 1993; PETERAF, 1993; VASCONCELOS; BRITO, 2004). Table 1 shows a chronological definition of the competitive advantage by some published authors.

Table 1 - Competitive advantage definition by author

(to be continued)

Author	Definition
Ansoff (1965)	"...this is the competitive advantage. It seeks to identify particular properties of individual product markets which will give the firm a strong competitive position.”

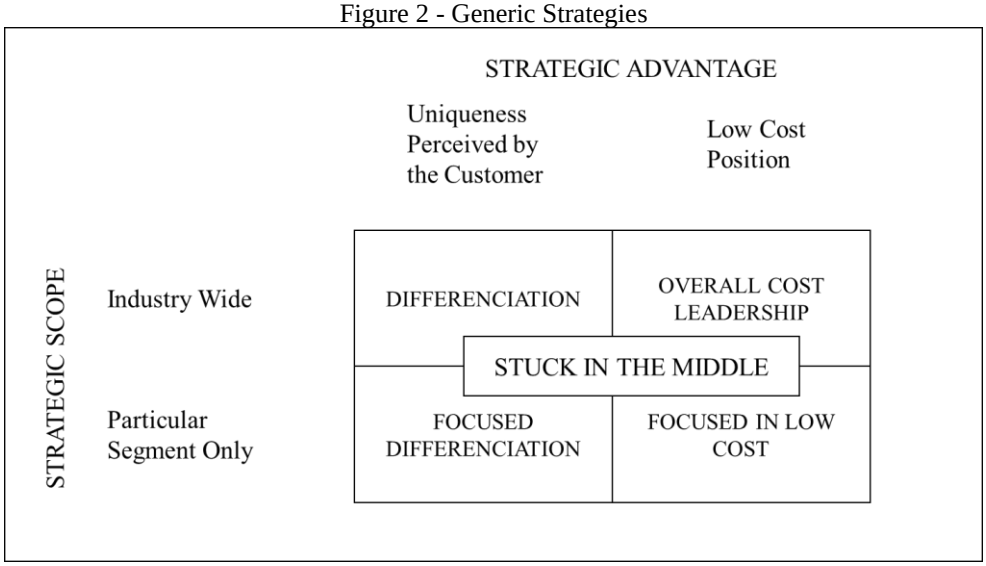
(conclusion)

Author	Definition
South (1981)	"competitive advantage as best general approach for achieving sustained business success. by prescribing a concentrated investment of resources in those enclaves of competitive activity which, because they are sheltered from the changing business environment and protected from intense global competition, offer the best opportunity for continuing profitability and sound investment returns."
Porter (1985)	"as a creation of better customer value compared to a firm's competitors by performing specific activities that are either more economically driven or superior in terms of quality or services, or a combination of the two."
Barney (1991)	"A firm has a competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors"
Ma (2000)	"the differential between two competitors on any conceivable dimension that allows one to better create customer value than the other"
Grant (2002)	"when two or more firms compete within the same market, one firm possesses a competitive advantage over its rivals when it earns (or has the potential to earn) a persistently higher rate of profiit"
Peteraf & Barney (2003)	"An enterprise has a Competitive Advantage if it is able to create more economic value than the marginal (breakeven) competitor in its product market.... The Economic Value created by an enterprise in the course of providing a good or service is the difference between the perceived benefits gained by the purchasers of the good and the economic cost to the enterprise"
Vasconcelos & Brito (2004)	"Competitive advange as resulting from the net influence of all idiosyncratic factors of a firm on his performance over a period of time, not considering other influence such as industry, temporal fator and statistical error"
Ghemawat & Rivkin(2006)	"Competitive advantage, as widening the wedge between customer willingness and supplier cost, in a unmatch way to their rival"

Source: Adapted by author

As illustrated on table 1, the value creation definition changed as the discussion evolved. To Porter (1989), the definition of a competitive advantage would be linked to the created value, limited by the production cost and the price paid by customers, in other words, the competitive advantage being the same as profit. This focus on profit is evident in his Generic strategy publication (figure 1), by working with lower costs or differentiating their products from their competition, these strategies would build a competitive advantage/profit.

Figure 2 - Generic Strategies

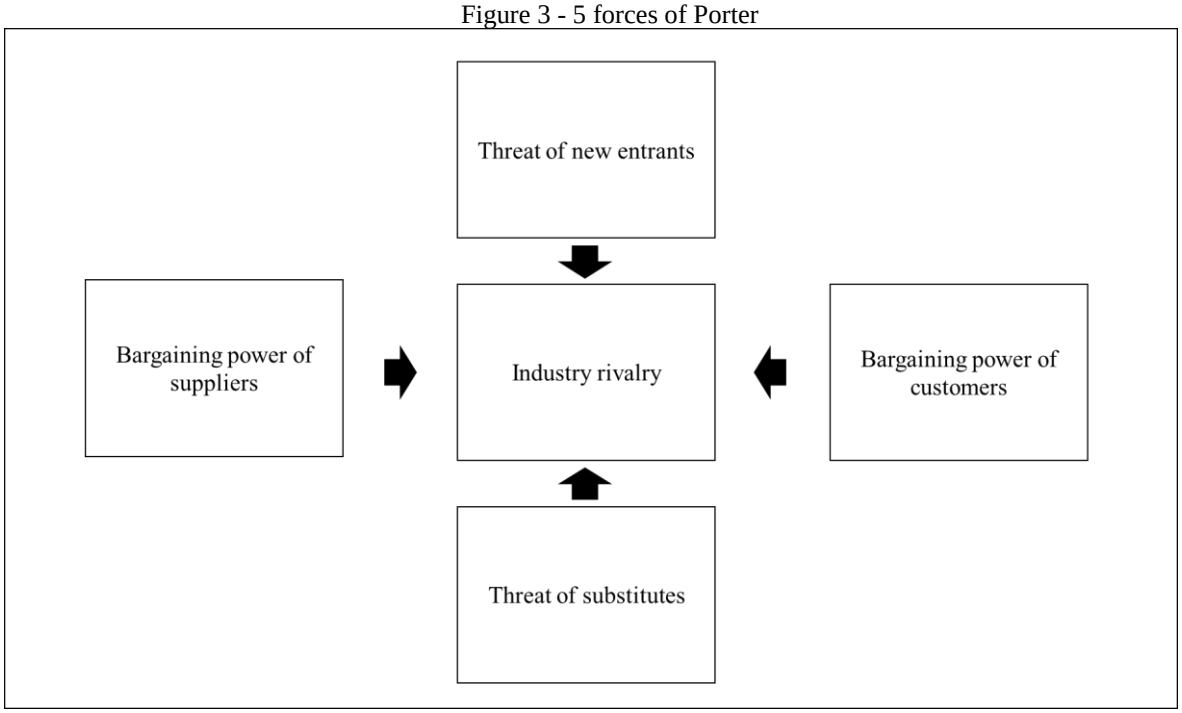


Source: Porter (1989)

Porter also recognizes that creating more value than the competitors allows a company to choose either to increase the price or not. If increasing the price the firm would increase its profit, but by following the market price the company might be preferred by the clients. By this interpretation it becomes clear, that profit is not the only outcome.

Later on, he concluded that in every market, the characteristics of competitiveness (and also profitability) is based on 5 forces: (1) Threat of new entrants, (2) Threat of substitutes, (3) Bargaining power of customers, (4) Bargaining power of suppliers (5) Industry rivalry.

Figure 3 - 5 forces of Porter

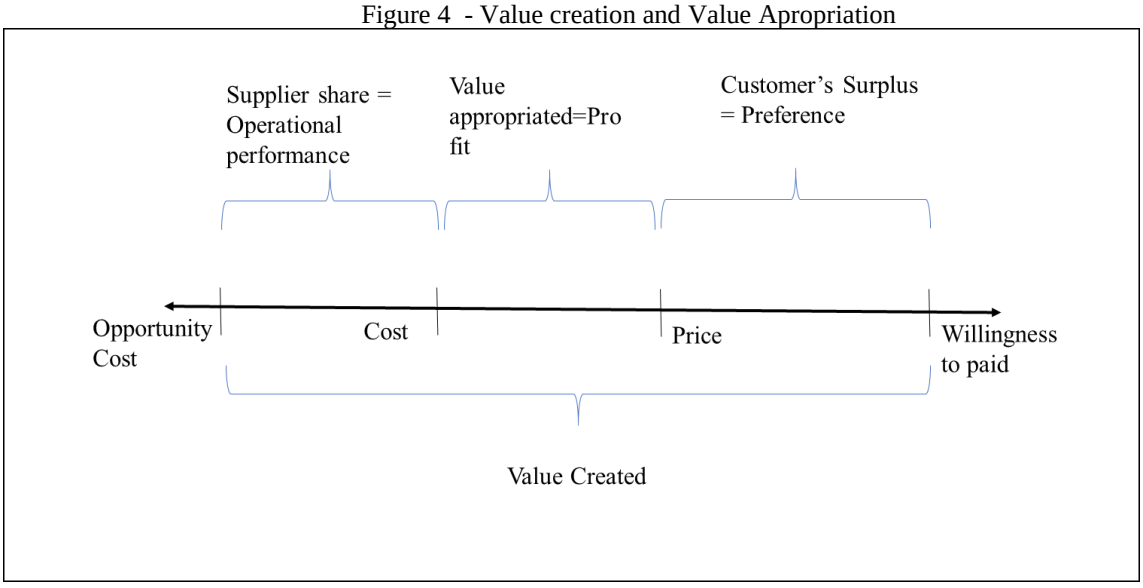


Source: Porter (1989)

The 5 forces of Porter show that the profitability or the competitive advantage are different for each industry as every industry defines how each product should be priced, the amount of costs, and the investment necessary to compete. For Porter (1989), the threat of new entrants limits the industry's potential profitability, since the attractiveness of the market, will attract new players, who will potentially produce more products and steal their market share, consequently reducing margins. Suppliers and buyers with enough bargain power will harvest the profit themselves. Intense rivalry inside the market will destroy margins by creating larger competition costs or transferring the value to customers due to the lowering of prices. The presence of substitutes lowers the prices thereby reducing the size of the market. This is why many previous studies focus on only one industry, as it is difficult to analyze different industries' competitive advantage at the same time.

Besanko, Dranove and Shanley (1996) introduce the Value-Price-Cost, to better show the dynamic of price and value created. He defines it as the difference of the "Willingness to pay" by the clients, considering the competitive and individual background of the client, and the price being the result of a negotiation between the players (HOOPES; MADSEN; WALKER, 2003). The distance between the value created and the price, is what could be offered to attract the customer (client captured value). The difference between the price and the cost is the firms profit (firm captured value) Brandenburger e Stuart Jr. (1996) further add to the value creation definition (figure 4) by describing it as being the difference in price between a supplier opportunity cost and the willingness to paid by the customers. Illustrating the importance of negotiating with both (client and supplier) to raise profit.

Figure 4 - Value creation and Value Apropriation

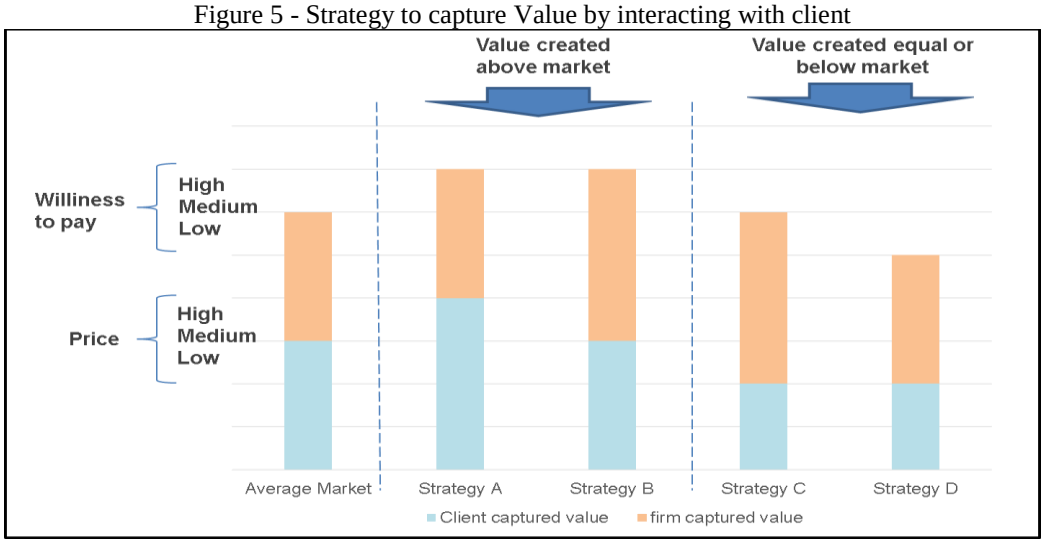


Source: Brandenburger e Stuart (1996)

Based on the illustration above, we can clearly understand why it is incorrect to only measure Profitability as a competitive advantage (COFF, 1999), it is also necessary to consider the *customer's surplus* and *supplier share* to estimate the firm's competitive advantage. The customer preference is the value absorbed by the customer and the impact it has directly on the firm's market share, whereas the suppliers share is the impact on the future performance since more profit is being absorbed by the supplier. This then becomes a resource to boost supplier capabilities.

This is why Coff (1999) was the first to point out that the competitive advantage might not necessarily correspond to a superior performance. Because based on the value creation model (BARNEY,1991, BRANDENBURGUER; STUART, 1996), this value can also be absorbed by the customer or the supplier. Bowman and Ambrosini (2000), describe the outcome, based on the value creation as depending on the firms strategy (Figure 3).

Figure 5 - Strategy to capture Value by interacting with client



Source: Adapted from Bowman and Ambrosini (2000)

Based on the figure, a firm in competitive advantage, can choose between strategy A and B. The firm gains profit margins or gives back the value to the clients, gaining their preferences (BOWMAN; AMBROSINI, 2000; CHATAIN,2011) and most probably gaining market share.

The capacity of maneuvering between the two outcomes, which are increased profitability and sales growth, will depend on how much value is added by the firm. The processes of creating value, vary within different businesses, therefore making the discussion related to strategy relevant.

Other authors analyzing the value creation and appropriation model (BRANDENBURGER; STUART, 1996), showed that an aliance and partnership, especially with suppliers will increase the value creation, impacting on the competitive advantage, by improving quality and enhancing innovation (INKPEN;TSANG, 2005; THOMKE; HIPPEL, 2002). other authors also stated that an aliance and partnership can reduce negociating cost and enable a more effective governance (BOSSE et al., 2009; DYER; SINGH, 1998). Meaning that a competitive advantage can reflect on relational assets, impacting on the operational performance. One of the most representing studies is from Dyer (1996 , 1997) and Dyer and Hatch (2006), and is done on the automotive industry, focusing on the supply chain management strategy and its' effect. This enhanced operational performance, can probably but not always, impact financial performance, on profitability, sales growth or even on market value (COMBS et al., 2005).

Early research has focused mainly on profit, since most firms' main objective has been to aim to creating profits for their shareholders (GHEMAWAT; RIVKIN, 2006; NEWBERT, 2008; PORTER, 1985). It is however important to understand that firms, frequently, will not be able to capture all value created, so the capacity of the value creation, i.e. the competitive advantage, will not reflect just as an increased profitability (CROOK, et al., 2008; NEWBERT, 2008). Though in some situations, not capturing the value or following the market price is a way to avoid competitors' attention and to lower the risk of imitation, and in this way, affect the performance of the company (MARCH; SUTTON, 1997). Since the profitability of the shareholder is also seen as a long-term asset, consistency and growth are better ways to evidence the competitive advantage (COFF, 1999).

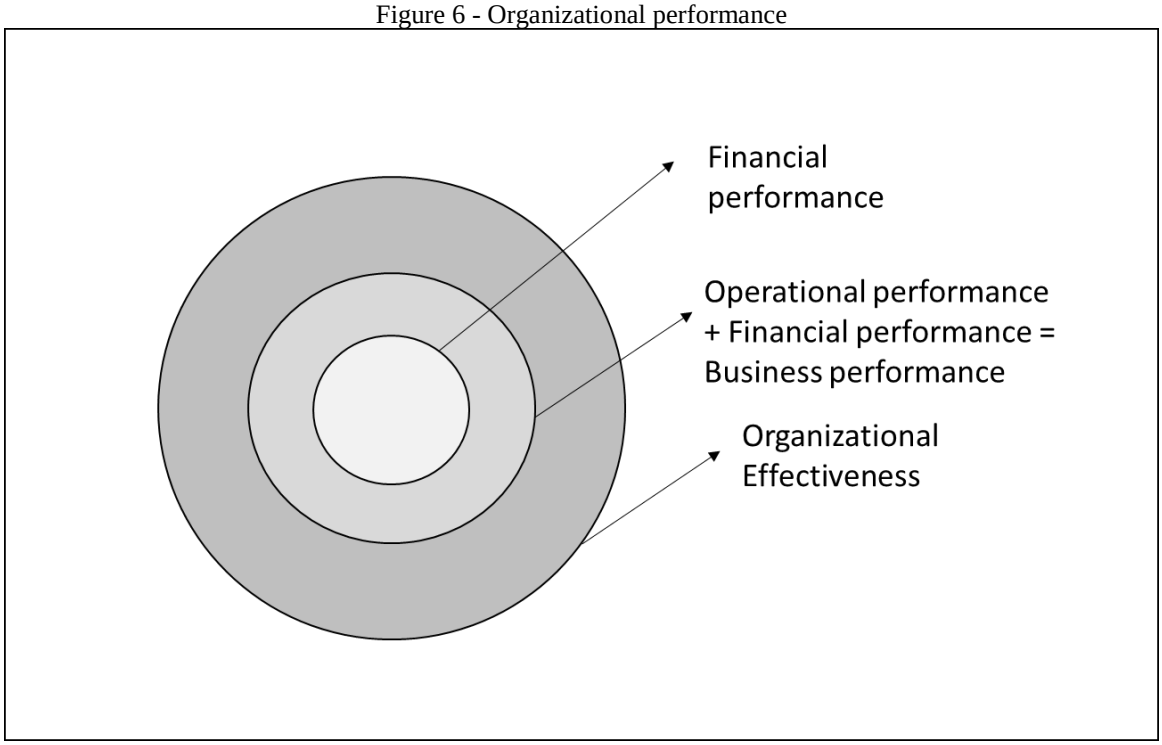
The discussion above is meant to explain that although financial performance has been discussed in many early researches as an empirical proof of competitive advantage, this has however later been proven to be incomplete, thus moving authors to explore the non-financial (operational) performances.

2.2 Competitive advantage and performance

After many discussions of the competitive advantage the definition has been made broader by several authors. The performance, linked to competitive advantage, has been

criticized as being too incomplete or not being robust enough (COMBS et al., 2005; RICHARD, et al., 2009; VENKATRAMAN; RAMANUJAM, 1986). Moved by this debate, Venkatraman and Ramanujam (1986) argue for an organizational performance definition, as being a wider definition, that would include financial performance and operational performance.

Figure 6 - Organizational performance



Source: Adapted from Venkatraman and ramanujam (1986)

Venkatraman and Ramanujam state that financial performance is the core of all business involving profitability (PORTER, 1989), market value (MORROW JR., 2007) and growth (PRIEM, 2007). The second part to be considered is the non-financial performance such as quality and innovation (COFF, 2010), that mediates between resources and organizational performance. Another author in a different study adds to the last definition: knowledge and learning (SUNG-CHOON et al.,2007), alliance and collaboration (DYER; SINGH, 1998). Venkatraman and Ramanujam (1986) later state that the financial and non-financial performance should be defined as the business performance.

Brito and Brito (2012) base on the value creation model, propose a financial performance model composed from: Sales Growth and Profitability. The authors argue that this would be more complete metric to measure competitive advantage and his value. His model is illustrated on below figure.

Based on the discussion above regarding a definition of the financial performance, this work aim to find empirical evidence of a competitive advantage by measuring a SFP: profit - and Sales/Market share growth above the average, creates three study objects; superior profitability (SP), superior sales growth (SSG) and SFP. The last object is an index composed from the previous two (table2), the first two being of equal importance in the equation.

Table 2 - Superior Financial performance index and composition

Concept	Variables	Detail
Financial performance index	1. Superior Profitability	=ROA/Market Average ROA
	2. Superior Sales Growth	=Sales growth/Market average sales growth

Source: Self elaboration (2017)

This index will not only show firms performing with a competitive advantage and with a SFP. It will also show the competitive parity and disadvantage, in a numeric representation. This numeric value should range from -2 to 2, with some exception of market outlier, representing an extreme advantage or an extreme disadvantage. To calculate the financial performance, the following data have been extracted from PIA (2011 and 2014):

a) net revenue;
b) net profit;
c) *Classificação Nacional de Atividades Econômicas* (CNAE) code.

To obtain the *Market average ROA* and the *Market average Sales growth*, Each firm have been be classified by industry following the *Classificação Nacional de Atividades Econômicas* (CNAE), in 4 digits. This is a special data treatment which allows comparability of different industries, since the previous discussion shows that each industry can present different levels of profitability and growth.

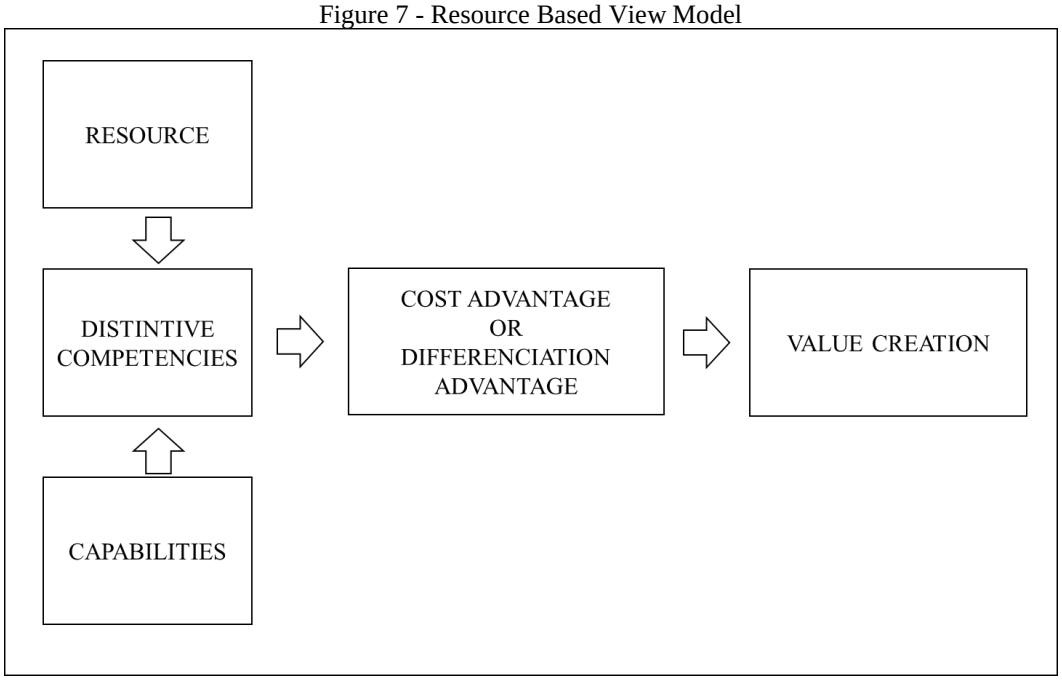
2.3 Resource based view

The study will now introduce the resource based view (RBV), explaining the link from this theory to that of the competitive advantage. This will introduce innovation, as an essential resource for a firm.

Some of the early strategy researchers (PENROES, 1959; WERNERFELT, 1984) started to investigate, from the inside and out, a model that highlighted the internal resources

of a corporation, and how the capacity of managing them would create value in order to achieve a competitive advantage. Wernerfelt (1984) created the definition of "a resource-based view" (RBV) of the firm and sought to analyze the companies by their resource background and not by the result of their products. He saw the firm as a bundle of assets or a resource tied semi-permanently to the organization. Later Prahalad and Hamel (1990) added the notion of a core competence by focusing on a critical category of resources – a firms capabilities. Papp & Luftman (1995) then added that distinctive competencies refer to all the things that makes the business a success in the marketplace (Papp & Luftman 1995). Barney (1991) established the link of resource as the primary force- of a competitive advantage. Figure 4 illustrates the link mentioned. Table 3 shows a chronological evolution of the Resource definition and the contributions of the different authors.

Figure 7 - Resource Based View Model



Source: Adapted by Author

Table 3 - Resource definition and contribution by author.

(to be continued)

Author	Definition
Ansoff (1965)	Classified firms' resources into three categories: physical, monetary, and human
Hofer & Schendel (1978)	Mentioned organizational resources (skills and knowledge) and technology (technical know-how)

(conclusion)

Author	Definition
Barney (1991) Barney and Wright (1998)	1-Defines resource as 'all assets, capabilities, organizational processes, firm attributes, information, knowledge etc., controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness'. 2-suggested that other than the general resources of a firm, there are additional resources, such as physical capital resources, human capital resource, human resource management-related resources and organizational capital resources.
Amit and Shoemaker (1993)	Proposed: physical, human and technological resources and capabilities
Miller and Shamsie (1996)	Classified resources into two categories: property-based and knowledge-based
Lee et al. (2001)	Argued for a distinction between individual-level and firm-level resources

Source: Adapted by Author

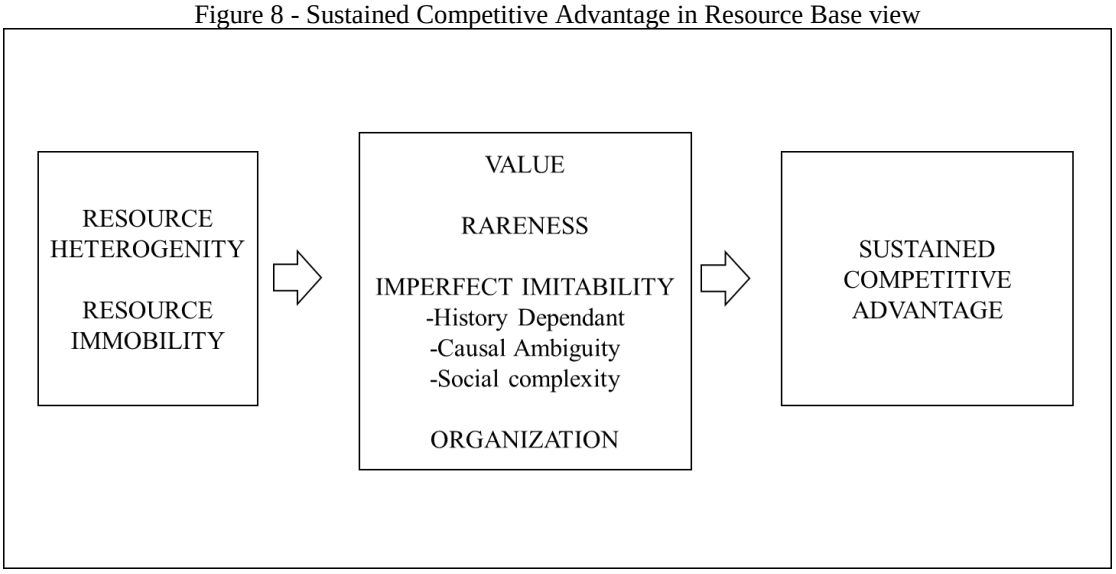
The researchers of the RBV made two important presuppositions: the companies inside the industries can be heterogeneous and the inputs or resources might not be perfectly allocated between them (BARNEY, 1991; PETERAF, 1993).

The heterogeneity implies that companies that do not compete between themselves are identical in the input or the resources that they control. This has been proven by following studies: Rumelt (1991) considered that companies within the same industry can be more different from each other than if compared to companies from other industries

The immobility of the resource implies, that in some companies, the resources are not frequently, dynamically or easily traded on the market, in other words, there is an allocation barrier for these resources.

Barney (1991) later stated that to attain profitability they need resources that need to be preferably: *Valuable*, *Rare*, Hard to *Imitate*, and in many cases that they are non-substitutable (BARNEY, 1991). Based on this statement, he created an analysis to classify a firm's resources and their proper usage in the *Organization*, calling it the VRIO analysis. He later added that each company would accumulate this unique resource, to support their strategy making it possible to achieve a differentiated performance.

Figure 8 - Sustained Competitive Advantage in Resource Base view



Source: Barney (1991)

Barney (1991) explains the importance of the aspect above through the following explanation:

Valuable: an useful resource should be primarily valuable, adding value by allowing the company to explore opportunities or neutralize threats. The firm also needs to test this value over time, since client needs, industry structure and technology can shift or evolve over time.

Rareness: if a resource is controlled by many firms, there is a limited chance for it to become a source of competitive advantage. Instead, if the resource is valuable but common then it might be a source of competitive parity.

Imitability: a firm that possesses a resource that is valuable or rare, can have at most a temporary competitive advantage. But if other firms are facing a cost disadvantage to imitate this resource or capacity, then this competitive advantage can become sustainable. The imitation can happen in two ways: duplication or substitution. Duplication happens when a different firm builds the same type of resource. Substitution happens when they build other resources that can replace the current one.

Organization: The potential competitive advantage depends on the value, the rareness, the imitability of the resource or the capability of the firm. But to use its full potential, firms need to be ready to take advantage of this resource or capability.

The resources of a company are certainly important, but how an organization uses these available means and supplies is as important as possessing the resource themself. The efficiency of physical, financial or personnel resources in the organization depends not only on

its existence, but also on how they manage the cooperation between the people and their capacity of adaptation, their capacity of innovation, the client and supplier relationship, and the learning of what is useful and not useful (JOHNSON, SCHOLES, WHITTINGTON, 2008).

Hamel and Prahalad (1994) argue that knowledge, know-how, intellectual assets and competency are the main drivers of the informational age. Evans (2003) and Tiwana (2002) also suggest that knowledge is the most important resource of a firm. Porter (1985) points out directly that there is a relationship between technology, resulting from knowledge, with competitive advantage (PORTER, 1985).

2.4 Innovation

As previously discussed, in the RBV lens, innovation is an essential resource in order to achieve a competitive advantage. This thesis focus on this resource, as being an essential part of the analysis. To better understand this resource, there is a need to clarify the essential definition of technology (FIGUEIREDO, 2009).

The accumulation of technology, also called, knowledge by an organization is what allows it to be innovative. Patel and Pavit (1997) argue that technology should be understood as a quantum of knowledge held by people and the organization. That knowledge has a codable part, through written documents (as are expressions, formulas, specifications, projects and manuals), but finds itself implicit, mostly, in people and organizations.

Von Tunzelmann (1995) states that there are some wrong associations to this definition. He differentiates the informational technology (IT), arguing that the information represents the sum of a total message generated around the world that is generally passively traded. He poses that technology is normally not tradable, and that it is linked to several individuals and an organizational learning process. He also argues that technology is not merely a product. According to him a product can consist of several technologies, and that what happens in a firm is the transformation from technology knowledge to product knowledge. This is explicit when looking at products that are gradually consisting of more technology, and when looking at technologies that are applied in several different products.

Figueiredo (2009) argues that technology merging and accumulating specific resources and stocks of technology is called technological capacity. According to him, the

technological capacity is stored in at least 4 elements: a) a techno-physical system, like a factory, machines and software; b) the managing organizational system and network, as in organizational routines, process, norm and technic; c) the people, that embody the human capital and d) product and services.

The technology definition, as seen until now, is mostly composed from implicit elements, which bring more complexity to the process of the technology transfer. This means that acquiring technology does not mean to possess it entirely. Therefore there is a need of a complex follow up during the technological transfer regarding the physical and implicit elements.

For a definition of the term innovation, one of the most commonly used definitions is from Schumpeter (1911), as he is one of the most recognized researchers to bring the technological innovation to the economic development discussion. He states a very important differentiation between invention and innovation. The first is the base of the technological knowledge, which has allowed new discoveries. It is highly specialized but claims that invention on its own is not profitable. On the other hand, innovation implies the transformation of different types or parts of knowledge regarding new products or services useful to the market or society as well as those being profitable, not only in terms of financial result, but also in term of process effectiveness. He also highlights five different concept of innovation:

a) a new product or a better quality of an existing product;
b) a new production method, that has not been tested by the transformation industry, and therefore might also be a new way of trading a product;
c) a new market, meaning a market that has not yet been entered by the transformational industry;
d) a new source of a raw material input or semi-product/component. Here it does not matter whether it existed before or not;
e) a new type of organization for the business, such as the introduction of megastores.

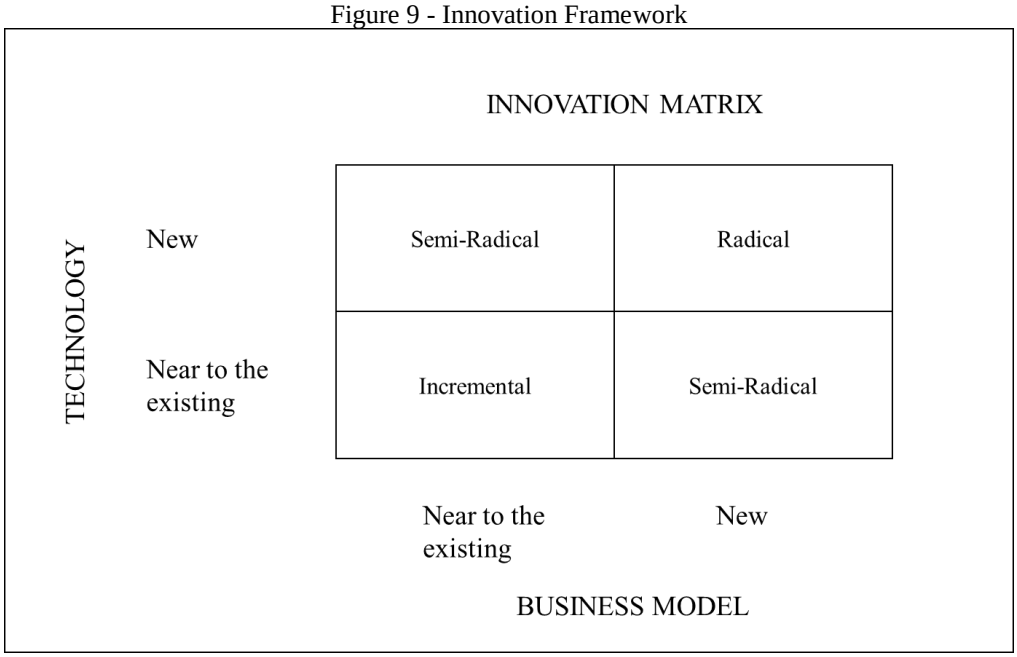
Later on Utterback(1971) added that innovation should not be a mere idea, but rather that should be “pushed” forward in order to produce an impact. In case of product innovation, it takes place as an invention that arrives as a “market entry” status. Process innovation happens on the first usage in the production stage, being a specialized solution for a certain need.

Teece and Jorde (1990) state that innovation should follow certain stages to hit a market. The stages are the following: search, discovery, development, improvement, adoption, and the trading of new products or processes, organizational structures and procedures. These stages imply that there will be a time delay that will impact on the firm's performance.

Since Schumpeter, several studies have been made in this area and there are several concepts of innovation described in literature. Faco (2009) states that each author and each situation demands a different definition.

Most of the literature about innovation presents 2 types of innovation: incremental and radical. But some authors, as Davila et al. (2006) also add an intermediary, called semi-radical innovation. Illustrated on figure 9.

Figure 9 - Innovation Framework



Source: Davila, Epstein and Shelton. (2006)

Incremental Innovation is a moderate enhancement of a current product or process. This is the most common type of innovation, frequently, receiving more than 80% of the financial resources in firms. This type of innovation can extract the best value from an existing product and service, without making a significant change to the product and avoiding a financial investment with a high risk (DAVILA et al., 2006).

A Semi-radical innovation is by definition the ability to boost the competitive level, by applying essential changes that are impossible to the incremental innovation. This requires a substantial change to a firm's business model or technology (DAVILA et al., 2006).

Radical innovation is a group of several new products and/or services that will be supplied in a totally different way. This can be seen as an exploratory exercise in a relevant direction, not knowing the final result nor whether it's a relevant element. It affects, simultaneously, the business model and the technology of the firm. Normally this results in fundamental changes to the competitive scenario of the industry (DAVILA et al., 2006).

Frequently, Radical and Incremental innovation are closely linked, since a radical innovation opens up for an extensive enhancement probability. In a competitive perspective, a radical innovation can change how the company works, but an advantage can only be sustained with a continuous enhancement of the product's performance. Rotwell and Zegveld (1985), state that the evolution of innovation is part of an accumulative learning process, inside the firm as well as with the relationship to clients.

Christensen (1997), argues that established firms tend to be better at improving what they do best, and new entry firms are more suitable for exploring new radical technology, bringing technology from other industries, where they are established and have already tested this technology.

Besides the intensity of innovation, several researchers (BESSANT; TIDD, 2009; TIDD et al., 2005) state that there are four dimensions, also called the four "P" of innovations, described as:

a) product innovation: the change of things (products/services) that a firm offers;
b) process innovation: the change of the way things (products/services) are created, offered or presented to the consumers;
c) position innovation: a change of the context in which the product and services are offered;
d) paradigm innovation: a change of the fundamental mindset that directs what the company does.

For this study's purpose, Product and process innovation have been adopted by this study, since this innovation definition matches with the definition from the *Pesquisa Industrial em Inovação Tecnológica* (PINTEC) from the *Instituto Brasileiro de Geografia e Estatística* (IBGE), their methodology is based on the Oslo Manual, 3th edition, 2005, from The Organization for Economic Co-operation and Development (OECD). More specifically inspired by the experience on harmonizing model proposed by the EUROSTAT (IBGE, 2016).

According to the OECD, Technological Innovation in product and process, involves a new technologically implanted product or process or a technologically enhanced product or

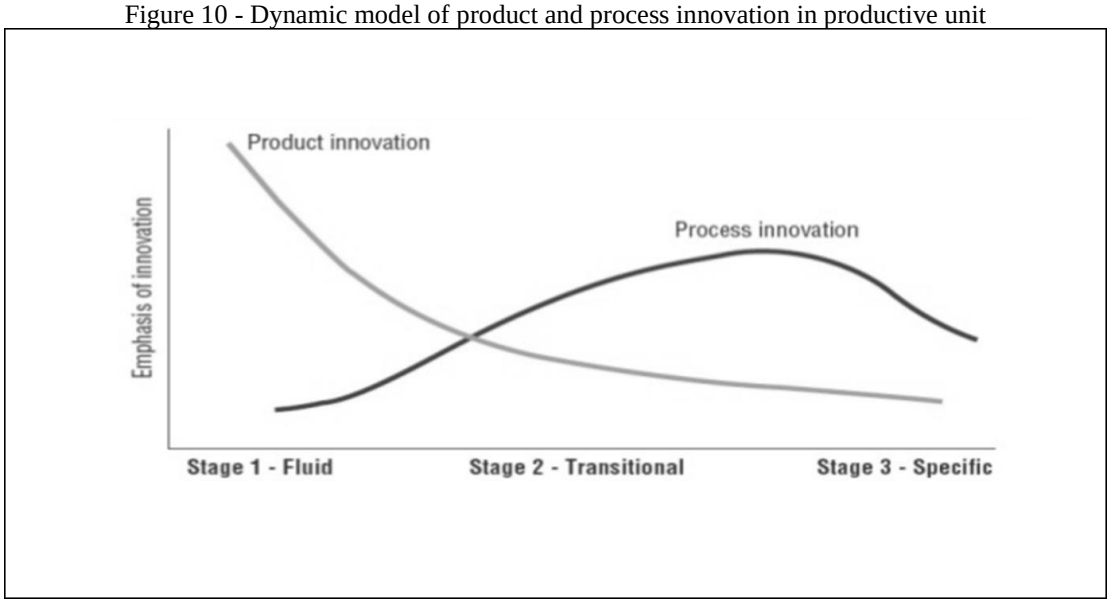
process. A innovation is considered implanted if there has been a market introduction (product innovation) or if it has been used on the production process (process innovation). This definition is the same as Utterback's (1971).

2.5 Product and process innovation

Some of the theories that focus on the product and the process innovation are based on the product life cycle by Abernathy and Utterback (1975).

The model of the product life cycle (ABERNATHY; UTTERBACK, 1975) illustrates the logic of innovation patters in many industries, but it might not be correct for all firms. The model (figure 10) shows the impact of innovation over time. The author states that cost reduction is seen as the main objective for a firm's innovation. At an early stage, product innovation can generate more impact, but once opportunities have been depleted and production volumes are high enough, new machines can be introduced to improve the production process, i.e. the process innovation. As a result, firms search for new processes only at a mature stage in an industry.

Figure 10 - Dynamic model of product and process innovation in productive unit



Source: Abernathy and Utterback (1975)

According to the authors, on the first stage of a business, also called the fluid stage, product changes are still frequent, since the product concept is not yet defined. Once the firm

and the consumer have achieved a level of experience this will evolve naturally to the next stage, so at first, innovation is focused more on the consumer feedback. As the result of this processes are flexible but rather inefficient. On this business stage competitors are still few and the focus is on maximizing the product performance (ABERNATHY; UTTERBACK, 1975).

On the second stage, also called the Transition stage, once a consumer becomes more experienced, the demand will increase and product innovation will lower, giving opportunity to manage process innovation and create better technical capability. Often, starting on main steps/process of production (ABERNATHY; UTTERBACK, 1975).

On the last stage, also called the specific stage, firms will focus on a cumulative improvement of the productivity and quality, commonly aligning suppliers with the firm's strategy. This applies to not only to the material suppliers but also to the capital suppliers with automation machines. (ABERNATHY; UTTERBACK, 1975).

The competitive strength of a product and the process innovation are being recognized by the academic and professional world as an important aspect to be considered in firms. That is why many articles, research projects and books have been published in the last decades, focusing on how to execute the product life cycle in the fastest and the most efficient way (HAYES ET AL, 2005).

The product innovation involves stages such as concept, design, development, validation and trading of the new products (RAINEY, 2005). For Edquist et al. (2001) product innovation happens when a new product is produced and sold for the first time (in a firm or country or region). According to DAVILA et al. (2006), modified and new product are the type of innovation that is the easiest to identify since clients can see the changes immediately. In a constantly changing market, clients are used to expect recurrent and meaningful technological change. This means, that consumers today expect the newest generation of electronical devices to have faster processors, better memory capacity, and so on compared to the previous generation of electronical appliances.

For Hayes et al. (2005) process innovation is commonly seen as a barrier to future innovation, once it makes the current technology obsolete. But many Research and Development (R&D) departments of processes and products co-exist in a way that brings synergy. In the biotechnology, semi-conductors and advanced material industry, new products are not traded without a strong process innovation.

Cooper and Edgett state that product and process innovation should be part of a firm´s strategy, because if this is not the case, R&D expenditure will be seen as a burden to be

reduced, during a financial crisis. This will impact the firm competitiveness in the long term. When there is a real commitment, and it is part of the core strategy, the probability of this happening is lower and is thus giving continuity to the competitive resource.

Lundvall and Christensen (2004) state that product innovation processes use knowledge and competencies from many employees from different activities within the firm through their interaction (interactive learning). For them there are 2 unique characteristics for product innovation: the first is *uncertainty*, since this is an essential part of the process, to achieve an objective that is first unclear believes, intuition and creativity become important roles in this interaction; secondly, we have *interaction and communication*, since the process depends on mutual interaction and learning, individual interests it can be conflictive in a context where resources and ideas are shared. This combination creates 2 effects, the link between a social relation and a commercial result and the effect on how people and the organization interact.

Although product innovation is the vanguard of all firm innovation, process innovation has a very powerful role in the competitive stage given that it has the capability to execute a process in a better way than the competitors. It is therefore an important part of a competitive advantage (TIDD et al., 2005).

For Davenport (1993) the process innovation possesses a working structure aiming for a clear result. It starts from the business point of view, enhancing the business through radical and creative changes. It involves a massive change in work flows, culture, organizational power, control, competencies and management practices.

Process innovation is not restricted to manufacturing firms for its role can be even bigger in a service operation, where clients interact directly with the operations department, since new services demand new operational capabilities.

2.6 Innovation and competitive advantage

Firms can achieve competitive advantage through innovative action. They will either find new forms to compete or more effective forms to compete in the same way. It involves investment in abilities and knowledge, physical assets and brand reputation (PORTER, 2008). The purpose of sustainable competitive innovation is to enable continuous performance

enhancement in the established market. Most of the time, firms that are successful in sustainable innovation are industry historical leaders (CHRISTENSEN et al., 2009).

The possibilities arising regarding new ways to compete are caused by structure changes in the industry. These changes are mostly unnoticed opportunities. To Porter (1989), the most common reasons for innovation to impact competitive advantage are:

a) new technologies: technology changes can provide an opportunity to create new products, new ways for trade, production and delivery, and including new ways of service support. This is the most common tool for strategical innovation. New markets are born when technological advancement enables the creation of a new product;
b) a new or changed necessity from the consumer: the competitive advantage is often created, when buyers develop new needs and therefore require a different value chain;
c) new industry segmentation: means that there is an opportunity to create an advantage when a new market segmentation appears or to find a new way to organize the existing segmentation. Such as new clients, new ways to produce certain items in the product line, new ways to reach a group of clients;
d) production input's oscillation of cost or availability: the competitive advantage often changes, when there is a significant change on any input cost, such as labor work, raw material, energy, transport, communication, media and machinery. This causes new conditions in the supplying industry such as new or different types of inputs with a different quality. A firm can obtain a competitive advantage by optimizing conditions with new resources, while their competitors are still working with previous installations and process designs.
e) new regulations: changes in government regulations, such as product standards, environmental control, restriction to entry and commercial barriers are other common stimulators of innovation. For industry leaders, that have run their business activities according to certain regulations it might be impossible to follow new government regulations (PORTER, 1989).

Previous empirical studies, also confirm that innovative firms, are those able to use innovation to improve their processes or differentiate their products and services and that are able to outperform their competitors in terms of market share, profitability, growth and market

capitalization as illustrated in Table 4. Simultaneously, innovation management poses many difficulties and risks: most of new technology is not suited for being transformed into a new product or service and even if they can be transformed, it might not be a commercial success. Tidd et al. (2005) states that innovation can raise competitiveness, but that it demands a series of knowledge management actions and other abilities from managers.

Table 4 - Empirical studies from innovation and financial performance

(to be continued)

Author	Data	Period	Independant	Dependant	Result
Odagiri (1983)	370 Firms in japan.	1969-1981	R&D expenditure	sales growth	Proved that R&D expenditure impact over sales growth and not the oposit.
Hall(1987)	1778 firms in US manufactory industry	1978-1979 and 1976-1983	R&D expenditure and capital expediture	Sizes (employee) growth	companies with R&D program, out performed 1 to 2% in growth. Capital expenditure has less impact that R&D expenditure.
Morbey & Reithner (1990)	134 firms is US.	1978-1987	R&D expenditure	Sales growth	found significant positive relation between both.
Andreassi (1999)	125 firms, in Brazil.	1994-1996	R&D expenditure and patent	New product sales, sales growth, cost reduction, market share.	R&D expenduture have a positive relation with sales growth. But not on profitability.
Klomp & Van Leeuwen (2001)	10,664 firms, in netherland.	1994-1996	innovation inputs (expenditure in co-innovation, R&D and others) and outputs (number of design, development testing and maketing)	Sales growth, employee growth and innovative sales.	innovative firms out perform in term of sales growth and employee growth than not innovative firms.

(conclusion)

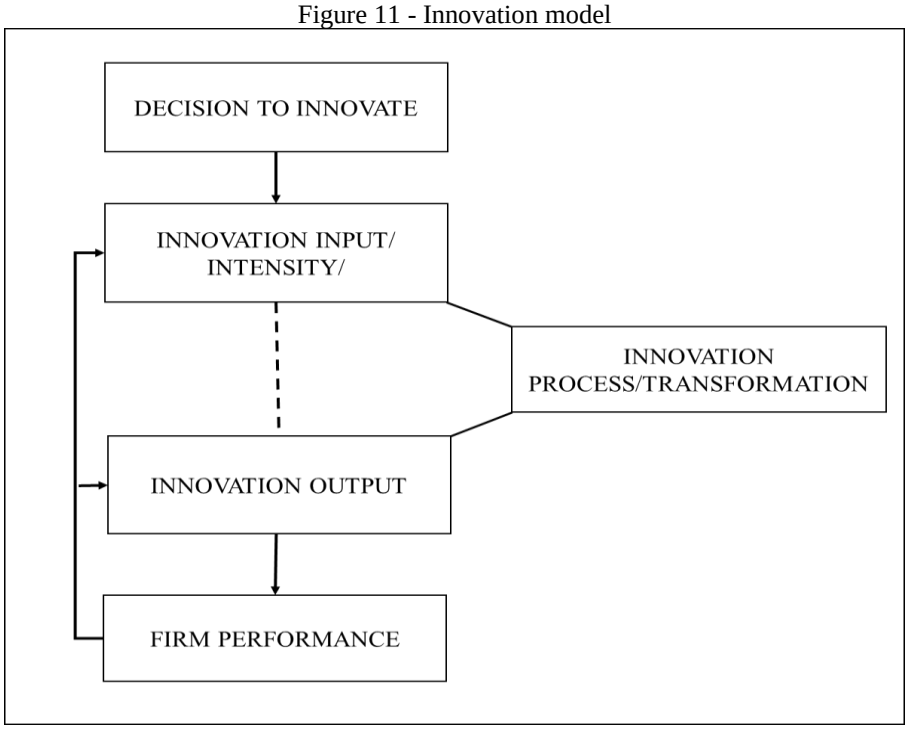
Author	Data	Period	Independant	Dependant	Result
Zamith, Brito e Morganti (2007)	62 companies, from brazilian quimical companies	1999-2001	innovation input (expenditures, employees by education,) and innovation outputs (new product sales)	ROA, EBITDA and Sales growth	R&D expenduture have a positive relation with sales growth. But not on ROA.

Source: Adapted by Author

As previously stated, and as seen in the above empirical studies, the effect of innovation on business performance is not immediate once innovation needs several stages to impact firms (TEECE; JORDE, 2000). Kafouros (2008) states that the time frame for maximum innovation impact depends on 3 factors: The time needed to complete the project, the time needed to introduce the product to the market and the time needed in order to gain market shares and for it to show on the revenue. He also states that this time lag should depend on the type of R&D and on the industry. In previous empirical studies, innovation introduced in year one, will only have an impact on business performance after some time. Diederen et al. (2002) states that this time lag should at least take 1 to 2 years. The duration of the competitive advantage will last until the firm loses proprietary control over the new technology or when other firms introduce an alternative to this technology (DOSI, 1988). The competitive advantage period can last longer or shorter, depending on the industry technological intensity, determining how fast systemic technological changes are in the industry. This work use a three year gap, which is the same amount of time that it has been presented by previous innovation authors. (ANDREASSI, 1999; KLOMP; VAN LEEUWEN, 2001; ZAMITH; BRITO; MORGANTI, 2007), using a gap from 2011 to 2014.

Within empirical innovation studies, most researchers use models that incorporate 4 stages, involving the decision to innovate, the decision on how much to invest (innovation input), the decision on how much result to expect (innovation output) and the impact generated on firm performance (figure 11).

Figure 11 - Innovation model



Source: Adapted from Kemp et al. (2003)

At the first stage, the decision to invest in innovation has often been linked to the size of the firm, since financial resources are more available in bigger firms, and the need to invest and survive the competition seem more possible for leading firms of the industries. This connection was confirmed by many authors (LINK, 1981; COHEN; KEPLER, 1996). Later, Teece (1992) argues that the discussion of the size of the firm has since lost its relevancy as boundaries of firms have become fuzzy in the recent decade, due to increasing strategic alliances and bilateral agreements (R&D).

At the second stage, the decision on how much to invest or the Innovation inputs are defined, often as financial resources invested in R&D, with some studies focusing on the total cost (LOOF et al. 2001; KEMP ET AL, 2003), while others put a stronger emphasis on the ratio of innovation expenditure of the total sales, also called innovation intensity (KLOMP; VAN LEEUWEN, 2001; CHUDNOVSKY ET AL., 2006). Another author argues that this definition is incomplete and adds that: a number of employees devoted to R&D(TIDD, 2001; MOTOHASHI,1998; LI; ATUAHENE-GIMA, 2001); expenditures on cooperation and external networking (KOSCHATZKY, 1999); and R&D installation unit (MOTOHASHI,1998) should also be considered as inputs.

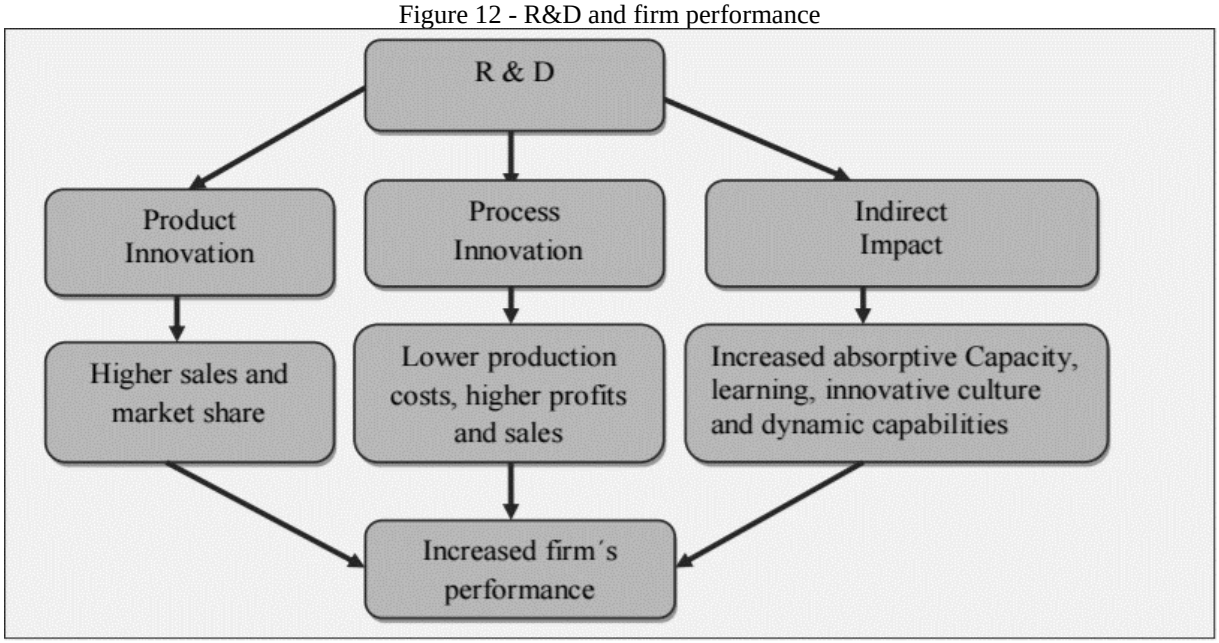
At the third stage, the expected result, also called the Innovation output, has been defended by different authors. They argue that effort and resources are not necessarily a result

of innovation, so there is a clear need to understand the dynamics of the transformational process, from input to output. Studies should show the efficiency of these investments, to enhance the impact on the firms performance. Contrary to the initial statement, Andreassi (1999) found in his empirical study that Expenditure on R&D was more relevant than the quantity of new patents on sales growth impact. For innovation outputs, the most common definition in empirical studies are: new product sales rate (KLOMP; VAN LEEUWEN, 1999; HINLOOPEN, 2003). Other authors add a less direct approach such as, quantity of new patent (TIDD, 2001; MOTOHASHI, 1998; WALKER et al., 2002, ANDREASSI, 1999), and quantity of adopted innovation (DANMANPOUR et al, 1989; GOPALAKRISHNAN,200). Loof et al.(2001) in a study including input and output found a significant positive relation between both.

Some authors (KLOMP; VAN LEEUWEN, 1999; KLOMP et al., 2002;LOOF et al., 2001) add a fifth stage; the innovation process, as the efficiency of transformation from input to output by different elements such as cooperation, subsidies and long term R&D.

The R&D department in a firm has an essential role when it comes to leading innovation, Kafouros (2008) argue in his theory that R&D impacts a firm performance in three ways (Figure 11): product innovation , process innovation and other indirect impacts. He states that the indirect impact will reflect on the absorptive capacity, the learning capacity, the innovative culture and the dynamic capabilities. This can be seen as the effect of an accumulated knowledge due to R&D activities (PATEL; PAVIT, 1997).

Figure 12 - R&D and firm performance



Source: Kafouro (2008, p. 26)

This study use several innovation input(Table 5) and innovation output (table 6)as part of the empirical analisys. But only R&D expenditure is adopted as part of the GI's empirical definition.

Table 5 - Innovation input Variables

Concept		Variables	Detail
Innovation Input	R&D Expenditures	1. Expenditure in R&D	=TOTAL R&D/net revenue
		2. Expenditure on external acquisition of R&D	=TOTAL Ext R&D/ net revenue
		3. Expenditure on new machine and equipment	=TOTAL Capital adqui/ net revenue
	Number of employees devoted to R&D by education level	4. Number of Researchers part time/full time with Doctorate degree	=Head count (Part time) =Head Count (Full time)
		5. Number of Researchers part time/full time with master degree	=Head count (Part time) =Head Count (Full time)
		6. Number of Researchers part time/full time with undergraduate degree	=Head count (Part time) =Head Count (Full time)
		7. Number of Researchers part time/full time below undergraduate degree	=Head count (Part time) =Head Count (Full time)
		8. Number of Technician part time/full time with undergraduate degree	=Head count (Part time) =Head Count (Full time)
		9. Number of Technician part time/full time below undergraduate degree	=Head count (Part time) =Head Count (Full time)
		10. Number of part time/full time Assistant	=Head count (Part time) =Head Count (Full time)

Source: Self elaboration (2017)

Table 6 - Innovation input Variables

Concept		Variables	Detail
Innovation Output	New product Revenue (ratio)	1. Net revenue (ratio) of New product for the firm.	=New product revenue/ Total Net revenue
		2. Net revenue (ratio) of New product for the firm, and Domestic market.	=New product revenue/ Total Net revenue
		3. Net revenue (ratio) of New product for the firm and global market.	=New product revenue/ Total Net revenue
	New product Export (ratio)	4. Export(ratio) of New product for the firm.	=New product Export / Total Net revenue
		5. Export (ratio) of New product for the firm, and in the Domestic market.	=New product Export / Total Net revenue
		6. Export (ratio) of New product for the firm and in the global market.	=New product Export / Total Net revenue

Source: Self elaboration (2017)

From the table above, innovation inputs will follow below criteria, extracted from the PINTEC (2014):

a) expenditure in R&D: involves all creative work, systematically made with the objective to raise the knowledge stock, and the use of these knowledge to

develop new application, such as new product, new process or improved process. Will included design, construction, prototype testing, pilot running and others related process;

b) expenditure on external acquisition of R&D: same activity described on number 1, but executed on other organization and acquired by the firm;

c) expenditure on new machine and equipment: purchase cost for, machines, equipement, hardware, specifically for implementing new product, new process, or improved process;

d) number of researchers part time/full time with Doctorate degree: personnel devoted in the R&D activities, as researchers (definition according to *Classificação Brasileira de Ocupações* – CBO) with a Doctorade degree;

e) number of researchers part time/full time with master degree: personnel devoted in the R&D activities, as researchers (definition according to *Classificação Brasileira de Ocupações* – CBO) with a Master degree;

f) number of researchers part time/full time with undergraduate degree: personnel devoted in the R&D activities, as researchers (definition according to *Classificação Brasileira de Ocupações* – CBO) with a undergraduated degree;

g) number of researchers part time/full time below undergraduate degree: personnel devoted in the R&D activities, as researchers (definition according to *Classificação Brasileira de Ocupações* – CBO) with a below undergraduated degree;

h) number of technician part time/full time with undergraduate degree: personnel devoted in the R&D activities, as technicians (definition according to *Classificação Brasileira de Ocupações* – CBO) with a undergraduated degree;

i) number of technician part time/full time below undergraduate degree: personnel devoted in the R&D activities, as technicians (definition according to *Classificação Brasileira de Ocupações* – CBO) with a below undergraduated degree;

j) Number of part time/full time assistant: personnel devoted in the R&D activities, as assistants (definition according to *Classificação Brasileira de Ocupações* – CBO).

And Innovation inputs will follow below criteria, extracted from the PINTEC (2014):

a) net revenue (ratio) of new product for the firm: net revenue (ratio from total revenue) originated from new product revenue, new for firm but not for domestic market.
b) net revenue (ratio) of new product for the firm, and domestic market: net revenue (ratio from total revenue) originated from new product revenue, new for firm and being new for domestic market.
c) net revenue (ratio) of new product for the firm and global market: net revenue (ratio from total revenue) originated from new product revenue, new for firm and new for global market.
d) export(ratio) of new product for the firm: export (ratio from total revenue) originated from new product revenue, new for firm but not for domestic market.
e) export (ratio) of new product for the firm, and in the domestic market: export (ratio from total revenue) originated from new product revenue, new for firm and being new for domestic market.
f) export (ratio) of new product for the firm and in the global market: export (ratio from total revenue) originated from new product revenue, new for firm and new for global market.

In the first part of the literature review, the purpose was to introduce the main literatures, where this study is theoretically grounded, allowing to introduce the study object. The following second part will show the main perspective of the study, showing the origin of the concept arising from a social concern regarding human sustainable development.

2.7 Sustainable development

The social challenge of the modern world is indisputable. Poverty, hunger, individual inequity of development, adding environmental dilemmas: pollution of water, air, and soil causing biodiversity and climate change, that will hit modern life politics and economics.

While there is a debate in several areas, the origin of sustainable development reflection is primarily focused on the ecology and economy, according to Veiga (2009, p. 21). While agreeing, Sachs (1995) highlights that development is a concept led by society, restricted by ecology and having economic as an instrument.

A more consolidated perspective for this new concept of "sustainable development" was proposed by the World commission over environment and development (WCED) published in 1987, creating the political concept, which calls for a more ethical attitude, being responsible for specifically the future generations but also the current generation (BRUSEKE, 2003).

However, this concept has been criticized for being too simplistic or dysfunctional. Based on Bruseke's statement, the integrity of natural resources should be kept independent from human preference, or can become a mere catchphrase with no conceptual, practical and operational sense (LELE, 1991; HOWWARTH, 1997; GIDDENS, 2009).

Another author has criticized the expression "sustainable development", for being contradictory, as the word "sustainable" implies continuity and balance, but development, implies change and dynamics. This means that environmentalist sides with "sustainability", and government and businesses focus on "development" (GIDDENS, 2009). Finally, some argue that sustainability can be achieved without a physical expansion, in other words, development without growing, should be the correct understanding of the term sustainable development (DALY; FARLEY, 2004; VEIGA, 2009).

Sustainable development is the process by which we move toward sustainability and being sustainable is having the capacity to continue on a long-term basis (PORRIT, 2007). Furtado (2005) supports previous authors, defining sustainable development as the quantitative and qualitative acquisition of products and services provided by nature paying attention to the economic, environmental and social needs of all current sectors of the society, without compromise the rights of future generations to having the natural products and services they need.

Also, if a sustainable development should be understood as the internalization of externalities, then it should be seen as the development that maximizes the liquid benefit in the long term to humanity, taking into account the cost of environmental degradation. The liquid benefit is to be understood as not only increasing rent, lowering unemployment and/or poverty, but also as having a healthier life condition and other benefits associated to a better quality of the environment. Under this concept, the focus of sustainable development should not be about

limiting growth, it should rather be about how to grow and develop something in a more sensible way, assuring that the benefit of the development is lasting (ANDRADE; WARD, 2000).

Two subjects have been very debated by academics. The first is regarding the natural resource usage, which brings forth several discussions about valuating elements of the environment, with monetizing externality, through market solutions. Many argue that this is the only way to plan the correct action to reach a more sustainable development. This proposition entails taxes and subsidies to correct market imperfection and the internalization of negative externalities, fixating the price of depletable natural resources as the Kyoto protocol proposes. The principle of polluter-payer is an example of an economical solution that suggest this line of thought (VEIGA, 2009).

However, several authors are against this logic, arguing that it is an economic reductionism by attempting to measure the unmeasurable. Regarding the fixed price, according to Veiga (2009), the criticism is due to a high level of uncertainty concerning the cause and effect with a different scale of time and space causing a high level of arbitrarily. For these critics, the difficulties when measuring and quantifying the ample effect of pollution is too high.

The second subject, discusses the possibility of the usage and the substitution of resources from two different perspectives. The first is called soft sustainability and the second is called hard sustainability (ANDRADE; ROMEIRO, 2009; CECHIN, VEIGA, 2010).

The concept of soft sustainability, is supported by the conventional theory of economic growth with an environmental economy, by Sollow (2000). The author argues that nature should not be considered an obstacle of expansion, because there is no absolute scarcity of natural resources. Making a natural capital with no need of a differentiated treatment, that can be substituted by anything manmade. This argument is based on tecno-centrism and has a great conviction when it comes to technological development. The author of this theory believes that a scientific progress will make it possible to substitute natural resources through innovation, overcoming the limitations that are halting economic growth. The confidence in technological development is due to many proven cases of new technology allowing the more efficient usage of resources while lowering consumption. Loyola (1997) adds to this by affirming that when a technological advancement progress reaches a level where renewable resources can substitute nonrenewable resources, then the environmental problem becomes secondary.

Several authors state that it is not always possible to substitute two different types of resource. Due to the unique characteristics of natural resources (CHECHIN; VEIGA, 2010),

especially when it is a critical resource - in other words that it is a not substitutable natural capital that is essential to life, that should receive a high priority in terms of conservation (O'CONNOR, 2000).

Several other authors (ANDRADE; ROMERO, 2009) state that if capital build by man can be perfectly substituted by natural capital, then reverse logic should be true too, and that there would be no necessity to produce this capital manmade, as the natural capital would already be available. Many authors support this way of thinking: complementarity and not substitution, maintaining two different capitals simultaneously (DENARDIN; SLZCACH, 2002). This argument would imply a limitation of usage to sustain the development within the biophysical limit and impact. This is the concept of hard sustainability.

Several researchers believe that in order to solve environmental problems. There will be a larger demand than the environmental economy can offer, insisting on traditional pricing and ignoring the systemically order of ecology (LOYOLA, 1997; CAVALCANTY, 2003; SACH, 2010; CECHIN; VEIGA, 2010).

Next this study will show the literature impact on the competitive advantage study, and the role of environmental innovation.

2.7.1 Green competitive advantage

Hart (1995) states that an industrial society will evolve to the point where a sustainable development is the norm, and that by then the technological, organizational, and human resources related to a firm's environmental goals will become even more valuable.

Earlier authors have however stated after looking at thought study cases that a green competitive advantage can be generated through more efficient processes, improvements in productivity, lower costs and new market opportunities (PORTER, 1991; HART, 1995; PORTER;VAN DER LINDER, 1995). This have become the base for a win-win scenario for further studies.

As discussed previously regarding sustainable development(VEIGA, 2009), the necessity to internalize externality is a necessary step to a real sustainable society. This avoided externality can then be valuable for consumer, with increasing environmental conscience.

In the attempt to quantify the value, Elkington (1998) proposed the triple bottom line. He argues that a business should achieve results in 3 sustainable dimensions: economic, social and environmental. Acting with an ecologic, economic and social balance (BARBIERI, CAJAZEIRA, 2009).

The triple bottom line proposition has influenced many studies, that aim to see the environmental performance and its link to financial performance. Illustrated below (Table 7).

Table 7 - Studies relating Financial and Enviromental Performance.

Author	Data	Environmental output	Financial performances	Result
Hamilton (1995)	463 Firm, from 1989	TRI emission from 1987	Returns (stock price reaction)	significant negative return on the day TRI emission data was first announced
Cohen et al. (1995)	all S&P 500 with environmental data avaliable.1987-1989, 1990, 1991.	Number of superfound sites, number and value of non-compliance fine, volume of TRI emission , number of oil spill, number of chemical spill, number of environmental litigation cases.	Return on assets (ROA), return on equity (ROE), total return to common share holder (risk adjusted and non adjusted).	73 of 90 comparison, between two portfolio, the low pollution portfolio had better financial performance. Although not always in a significant level.
Hart and Ahuja (1996)	127 firms in SIC, listed in S&P500 , 1989-1992.	emission reductions based on TRI from IRRC corporate environmental profile data from 1988-1989.	Return over sales (ROS), Return over assets (ROA), Return over equity (ROE). From 1989-1992.	pollution prevention have a positive influence on financial performance within 1-2 years. ROE take longer than ROA and ROS.
Cordeiro and Sarkis (1997)	523 firms in SIC codes 2000–3999 reporting under TRI regulations, 1991–92 (environmental performance), 1993 (economic performance)	Change in the sum of TRI releases that are recovered, treated or recycled on-site and releases from remedial actions or catastrophic or similar events	One-year and five-year industry analyst earnings-per-share growth forecasts from Zacks Investment Co.	High environmental performance is found to be significantly negative related to one-year and five-year earnings-pershare growth forecasts (based on industry adjusted values)
Edward (1998)	51 environmental leader in eight industry sector (Financial times) each matched to 3-5 UK firm, 1992-1993.	In-Dept positive assessment of various aspect of each firm's environmental performance and management base on product and service, environmental disclosure by the firm, GHGand ODS emission, packaging and labellling.	Return of capital employed, return on equity, from 1996.	in 31% comparison between portfolio of environmentally high performing firms and other firms, the latter performed worse, though not significant level in all cases.

Source: Adapted Wagner and Shaltegger (2001)

Earlier studies on financial performance have not necessarily found a positive relation concerning the environmental performance. Wood and Jones (1995) attribute the inconsistent statistical finding regarding the relationship between an environmental and a financial performance to a “stake holder mismatching” or to comparing the economic outcome desired by one set of stakeholders (e.g. a shareholder) to the corporate action desired by another set of stakeholders (e.g. an environmental activist). By this statement, we can understand the results found by Hamilton’s (1995) study, as a shareholder does not act with the same mind set as an environmental activist, and that market share prices are not appropriate to measure a firms value or created value. Furthermore, other financial indexes such as Profitability(ROA) and Growth are better to represent a firms competitiveness. Such statements are confirmed in the positive relation in later study results (COHEN et al., 1995; HART ; AHUJA, 1996; EDWARD, 1998).

Wagner and Shaltegger (2001) argue that while many empirical studies indicate negative short-term (1-5 years) effects of high environmental performance on economic performance, means that company pay an upfront cost, absorving externality. But on the long term most studies show positive effect.

To better understand how an environmental strategy can impact positively on a firm’s performance, there is a need to return to the value creation discussion. Prahalad (2005) and Hart (2006) state that social responsibility by business can provide several opportunities for value creation. This is the consequence of a political, social, economic and environmental convergence allowed by the sustainable development discussion. That can be messured on best condition using the triple bottom line method.

Hart (2006) presents an improvement of the value model presented by Hary and Milstein (2003). Structuring a theory in four dimension, as the below figure illustrates.

Figure 13 - Value model

Source: Adapted from Hary and Milstein (2003)

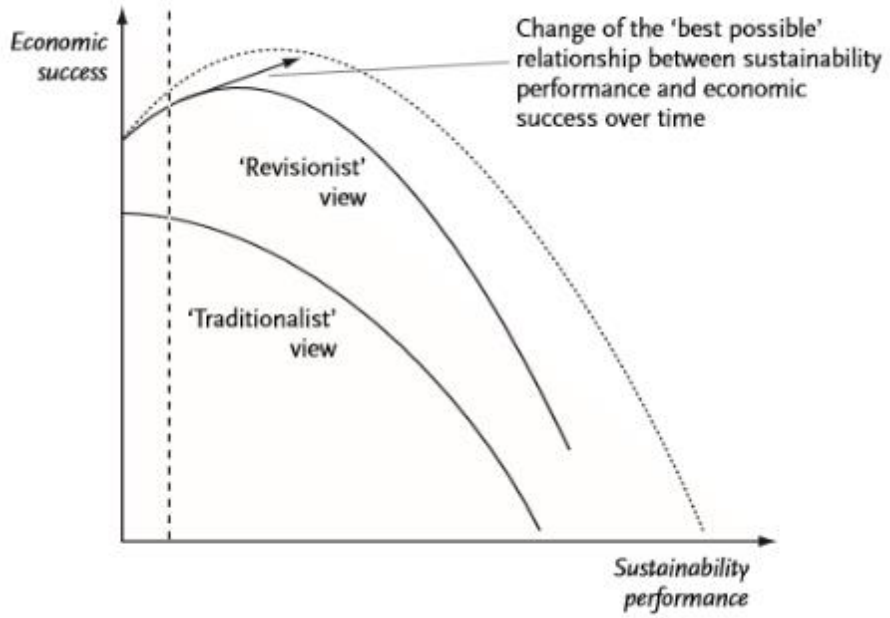
Hart (2006) states that sustainability is a multidimensional concept that cannot be approached by a unique corporate action. He furthermore affirms that businesses must have a good performance in these 4 dimensions if they want to continue to create value. According to his model, the two important drivers to create value are: organizational change and technological innovation, through green product and process innovation. While external driver are related to stakeholders which will impact on a firm value through positive reputation.

One of the most difficult elements to quantify by value is the reputation. Based on the RBV, Hall (1992) states that the reputation is an important intangible concept, although there is a probability of impacting customer preference the environmental reputation is even more meaningful. Souza (2004) adds to the GI research by stating that when businesses develop an environmental strategy adopting practices that allow cost reduction and/or product differentiation, this will lead to a better reputation in society, and can amplify their market position, driving it to a win-win condition. This is the hypothesis that drives businesses when it comes to proactive environmental practices. Zylbersztajn and Lins go even further, by arguing that small, medium or big firms that do not incorporate social-environmental sustainability in their business strategy, refusing a state partnership by having a narrow vision of the business boundaries risk being banned from the business. The reason being that these businesses are increasingly being considered responsible not only for their activities, but also for their supplier's, their surrounding communities and by the people that uses their products (SAVITZ, 2007).

One of the most debated elements in the competitive environment, has been the role of regulation as this role can influence the pace and the direction of the firm (HEMMELSKAMP, 1997; RENNINGS; RAMMER, 2011). It possesses two conflicting views regarding a regulation. Wagner(2003) and Schaltegger and Synnestvedt (2002) define this as traditional view and Revisionist view. The first view is an economic approach. It assumes a tradeoff between the environmental regulation and productivity. By implementing regulation, environmental cost are internalized, but undertaking additional expenditures in order to abate pollution and reduce environmental damage there will be a higher cost, resulting in a reduced profit and competitiveness (LUKEN, 1997; CLIFF; WRIGHT, 2000). The second view states that regulation can drive innovation, and that this will impact positively on a firm's performance. This view has been supported by many authors, stating a win-win scenario (PORTER; VAN DER LINDE, 1995). There are two main arguments: Firstly, that regulations will boost environmental innovation leading a change in production, which may reduce production costs or may lead to a change in the customer awareness, taste and preference, which may lead to an increase in profit or sales growth above the market(PORTER,1991; PORTER; VAN DER LINDE, 1995; SCHMIDHEINY, 1992). Secondly, this innovation may benefit from a first mover advantage, and/or may increase competitiveness obtaining a niche market, based on an environmental friendly reputation (ESTY; PORTER, 1998). Furthermore, as GI are related to green knowledge, industries and countries should have to build up their own green knowledge when they want to be competitive in future market, even when it is financially not very attractive at the moment (STUKI; WOERTER, 2016). Policy instruments as well as regulation should stimulate inventions in this area of large importance.

Based on the revisionist approach, some authors state that an environmental performance has positive but nonlinear, inversed U-shape (LANKOSKI, 2000; WAGNER, 2009; SCHALTEGGER; SYNNESTVEDT, 2002). Their argument is based on studies of environmental and financial performance, showing nonlinear results.

Figure 14 - Value model



Source: Schaltegger and synnestvedt (2002); also Wagner (2003)

Karagozoglu and Lindell (2000) have conducted a study to test the "win-win" hypothesis interviewing 83 American company's directors. They conclude that this is a possible hypothesis, stating a positive association between environmental innovation and competitive advantage, and between environmental, financial and competitive performance of companies. However occasionally an environmental practice can raise the product cost or reduce the quality perception of consumers. Consequently, when looking at it from a profit perspective, businesses will need to look for a balance between and environmental practice and the market expectation. In other words, the win-win hypothesis is possible under certain conditions. This means that it is necessary for businesses to have a constant and evolving environmental strategy driven by learning. The relationship between the environment and the business world is complex and requires a good management and good organizational skills in order to learn how to transform their environmental strategies into a competitive advantage.

Some author base on the tradicionalist view, argue that despite future market potential for greener product, firm are probably not willing by them self to invest in green technology, as GI currently show lower return than non-GI (MARIN, 2014; SOLTMANN et al., 2014).

The debate over this hypothesis, in other word, if environmental investment can be profitable to businesses or raise their competitiveness, was also approached by Reinhardt (1998) and Orsato (2002). Reinhardt (1998) state that green strategic advantage and environmental

investment's profit deepen on the business condition. Orsato (2002) adds, depend on the business economical principle, the market structure, his position within the structure, and his organizational competence. In other word, while it does pay to invest in environmental strategies, the financial and strategical advantage can be different on each firm.

Sharma et al. (1999) e Sharma (2000) classified the environmental action of seven Canadian Oil companies for 15 years as active and reactive. Active were those that created a competitive advantage, through the organizational image, identity and reputation improvement anticipating industrial patters and regulations. Reactive were those that took action due to governmental/institutional regulative/coercive action. They stated that an environmental strategy are influenced by an executive perception of an environmental problems, if they consider them as tread or opportunity. Proactive businesses, include an environmental sustainability in their business vision, adopting it into their organizational mission. This legitimacy is essential to the corporate identity as it helps structure decision and employee action and differentiates a proactive organization, by facilitating experimentation, proportionating criterias for decision making to areas such as materials, processes, waste systems, operations and new product development. This changes significantly the model of authority, responsibility and control, including the environmental performance as a part of the employee performance review (SOUZA, 2004).

After understanding the essential role of the technological innovation within the sustainable development and competitive advantage study, the following discussion will focus on literature's empirical studies.

2.7.2 Green innovation

The definition of GI has some variations (table 7). One of the publicly known definitions is from OECD (2009): *"the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)"*.

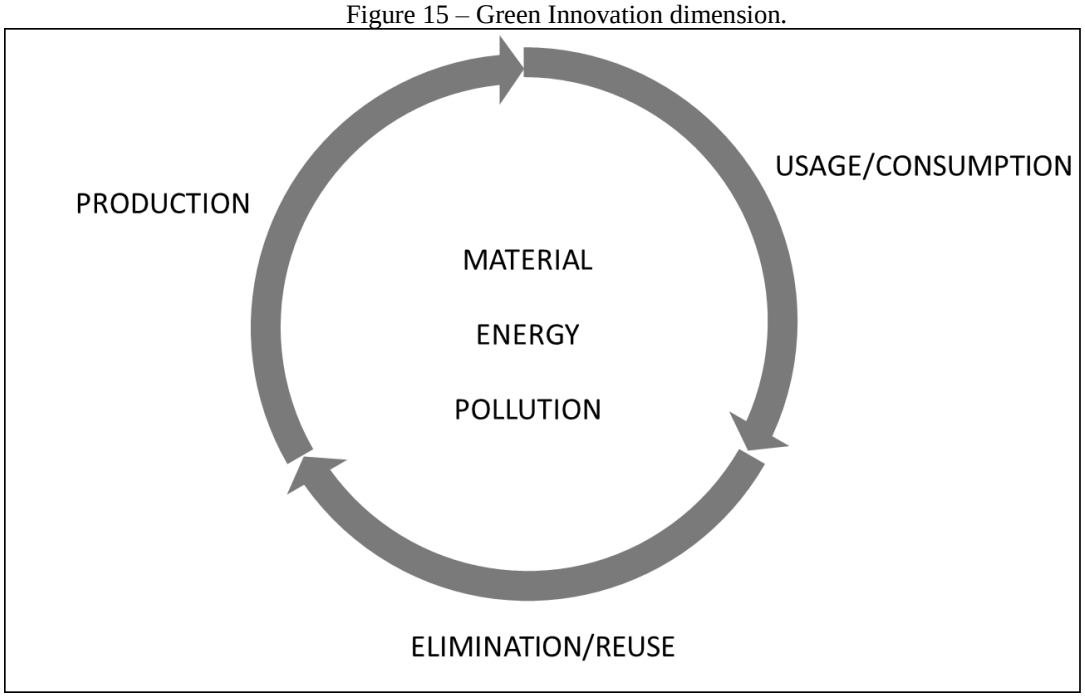
Table 8 – Green Innovation definition by author.

Author	Definition
Driessen and Hillebrand (2002)	Green Immpvation reflect as a tangible product, such as a energy efficient lightbulb or be less tangible, as service or standard behavior.
Chen et al. (2006)	as hardware or software innovation that is related to green product or process, including the innovation in technologies that are involved in energy saving, pollution prevention, waste recycling, green product design, or corporate enviromental management
Dangelico and Pujari (2010).	is a name commonly used to describe the effort to protect or enhance natural environment, saving energy and/or resource, reducing toxic element, pollution and waste
Ottman (2011)	is to innovate, at the concept and developing phase, of new product and service (including material, and technology), capable of executing same function as existing product, with less environmental impact.
Mulvaney and Robbins (2011)	environmental innovation or eco-innovation aim for reducing natural resource and the negative on the ecosystem, such as air, land and water emission. Innovation can be as a product, service or socio technical system (process).
Kesidou and Demirel (2012)	green technological innovation include many type of innovation, which explicitly emphazise the reduction of environmental impact, ranging from innovation from product, processes, marketing and organizational methods to social and institutional structure.

Source: Adapted by author (2016)

When analyzing from different angles, GI can be seen as a complex process with multiple perspectives (figure 15). It possesses three main environmental focuses: Materials (including water), Energy and pollution (waste that impacts water, air, soil). And the Product life cycle: Production, product usage and elimination. Danjelico and Pujari (2010) state that not all products have an environmental impact in the product life stage, but most have an impact in at least one stage. They also state that it is the result from the interaction between innovation and sustainability that has become a strategic priority between theory and practice.

Figure 15 – Green Innovation dimension.



Source: Self elaboration (2017)

Different companies may have different designs of products, and may produce their products using different processes and technologies, which results in different environmental performances in terms of energy and water usage and waste and pollution generation (EKINS, 2010).

Green product innovation has been considered an important factor for achieving growth for firms (DANGELICO; PUJARI, 2010), and developing greener products contributes to the reduction of materials, energy usage and pollution prevention along a product life cycle.

Mulvaney and Robbins (2011) state that green product innovation, also implies a green process innovation, such as clean technology, renewable source of energies, usage of nonhazardous materials and biodegradable materials, making the separation between the two hard.

It is a common proposition that innovations are the sources of the competitive advantage. (ZOLLO; WINTER, 2002). And some researchers explain that GIs generate a competitive advantage through more efficient processes, improvements in productivity, lower costs and new market opportunities (HART, 1995; PORTER; VAN DER LINDER, 1995).

Russo and Fouts (1997) stated the importance of quantitative data, to assure the quality of the study. Many previous studies have shown contradicting results and the author argues that this is due to self-reported data, using questionable social responsibility measures (WOOD; JONES, 1995). In his study, he uses the COMPUSAT data base, collecting Return

Over Investment (ROA) from financial report. And regarding the environmental index he classifies it based on several replies from firms, to assure the data quality. This statement will be considered in the later methodology adoption.

Some other authors (LANKOSKI, 2000; WAGNER, 2000; SCHALTEGGER; SYNNESTVEDT, 2002) propose that GI and competitive advantage have a positive but non-linear (u-shaped) relationship.

However as previously mentioned, some researchers argue consumers are not yet a driving force (THOGERSEN, 2006; SANDHU et al., 2010) due to consumers not willing to pay premium for green products (MICHAUD; LLERENA, 2011). Contradicting previous studies (PORTER; VAN DER LINDE, 1995; HENRIQUES; SADORSKY, 1996).

According to Prahalad (2009) innovation driven by sustainability will produce a sustainable competitive advantage in a changing climate scenario, based on his several case studies from selected business, but there is still no clear study proving this relation at a larger scope in Brazil, by relating the financial performance, as a competitive advantage, and green innovator, high lining GI from a traditional innovation approach.

The following hypothesis have been tested to achieve the main objective of the study:

a) H1: green innovation posseess a positive relation with superior firm growth;
b) H2: green innovation possess a positive relation with superior profitability;
c) H3: green innovation possess positive relation with superior financial performance.

Within the innovation, the role of cooperation has been studied by several authors. Hamel and Prahalad (1995) state that cooperation helps the chances of survival by anticipating in a more efficient way through a learning process of collaboration. Later confirmed by several empirical studies, (VEUGELERS, 1997; VEUGELERS; CASSIMAN, 1999; FREEMAN, 1991). Freeman (1988) adds by pointing out in a clearer way how the 3 main reasons of innovation failing is due to communication failure or relation problems. He argues that internal and external cooperation facilitate innovation, by connecting with laboratories and universities, and especially competitors by forming a R&D group facilitated by the government. This study was based on Japanese firms. De Marchi (2012) also states that the cooperation with external partners is even more important for green innovators than for other innovators.

Chesbrough (2006) states that innovation, that before was generated in big companies and universities now tend to happen more frequently in university labs, high tech

start-ups and spinoffs of great corporations. This makes it more necessary for firms to create organizational structures based on open innovation. This fact reduces the negative results of an innovation process that create an unexpected outcome, by sharing technology with an organization that sees value in the new technology. In Chesbroughs explanation, this can only happen when firms have their own internal R&D, that can identify the opportunity of sharing and creating value, consequently, collaboration does not mean that there is no need of an internal R&D. On the contrary open innovation structures enhance both internal and external technological investment.

Some authors also state that this is not a perfect condition, even when knowing the importance of the client and supplier of their company, it is highly unlikely that a firm can have a perfect harmonious relationship and coordination with the value chain of their client or supplier, due to the difficulty of negotiating agreements and coordinating different activities. (PORTER, 1989).

Previous empirical study exploring the links between environmental innovations and competitive advantage measured by business performance have mainly reported about the positive relationship (RUSSO; FOUTS, 1997; CHEN et al., 2006; WAGNER 2009). Illustrated on below table.

Table 9 - Empirical studies of GI.

				Competitive advantage		(to be continued)
Author	**Data**	**Period**	**Environmental output**	**Operational Performance**	**Financial performances**	**Result**
Russo and Fouts (1997)	243 firms in US, from COMPUSAT.	1991-1992	environmental position of firm(5 qualitative scale classification)		Profitability/ ROA	Proved that environmental firm classification has positive relation with ROA. And this relation is strengthened in high growth industry.

(conclusion)

				Competitive advantage		
Author	**Data**	**Period**	**Environmental output**	**Operational Performance**	**Financial performances**	**Result**
Chen et al. (2006)	232 electronics firms in Taiwan.	2004	Product innovation(material with less: (1).pollution, (2).energy usage (3).more productive(4).easier to recycle) and process innovation (process with:(5) less emission of pollution. (6) allow recycling and reusing, (7) less water electricity , coil or oil.(8) allow less material) , based on ISO14031.	4-quality, 5-R&D capacity, 6-management capacity, 7-reputation/image, 8-first mover advantage.	Qualitative data 1-lower cost 2-profitability 3-growth.	seen that environmental product and process innovation have positive correlation with competitive advantage. The first innovation having stronger correlation than the second.
Wagner (2009)	2095 manufacturing firm from Europe. From the EBAB	2000-2001	Environmental index from reduction of (1) water use, (2)use of energy (3)non renewable resource (4)toxic input (5)solid waste (6)soil contamination (7) water waste (8) emission to air (9) noise (10) smell (11) landscape damage (12)risk of sever accident	6-improved insurance condition 7-corporate image 8-product image 9-new market opportunities 10-short term access to bank loan 11-owner share holder satisfaction 12-management satisfaction 13-worker satisfaction 14- recruitment and retention	Qualitative Data 1-lower cost (cost saving) 2.1-short-term profit 2.2-long term profit 3-Sales 4-Market share	seen that relation between environmental and economic performance is positive but non linear.

Source: Adapted by author (2016)

Chen et al. (2006) and Wagner (2009) use different environmental output definitions. The first uses a commonly used definition by ISO14031, an environmental certification system used by 319,496 firms around the world (2015). Wagner uses an environmental definition adopted by the European Business environment barometer survey. This work use PINTECs environmental data and several similarities and differences on variables from this work is illustrated in ANNEX 2.

Russo and Fouts (1997) use secondary data, which is financial data from the COMPUSAT and environmental data from the FRDC official data.

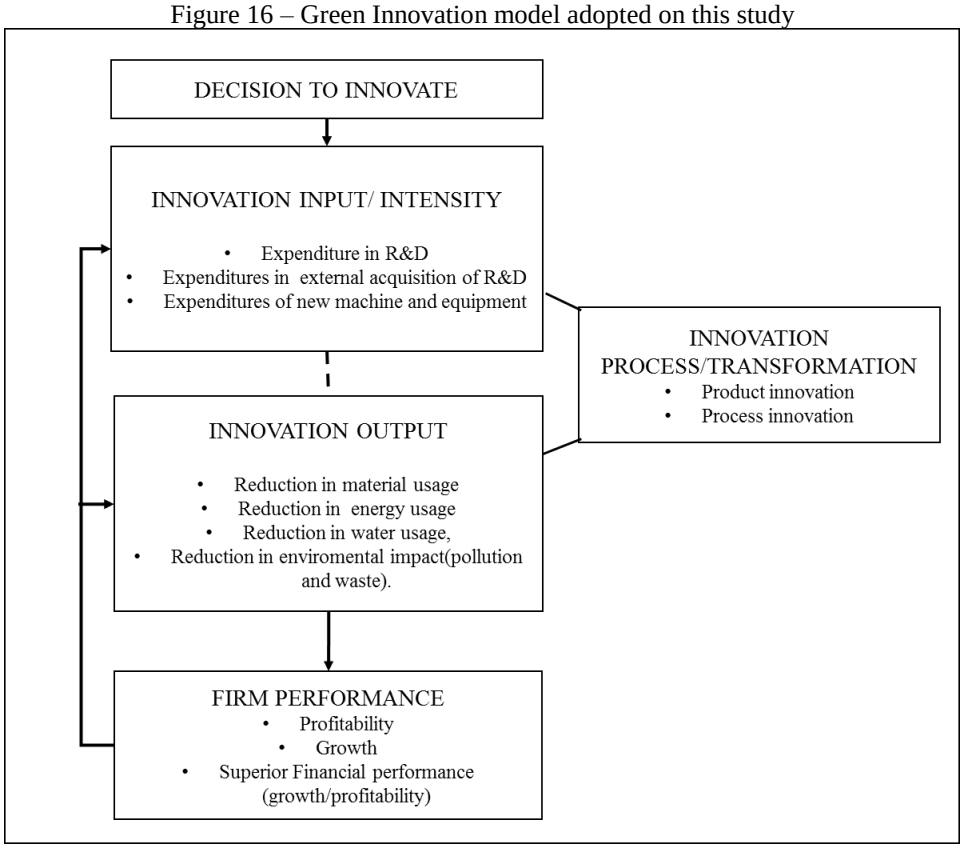
In Brazil, Arenhardt et al.(2016), use the same method as Chen et al (2006), and study GI, using an empirical method collecting information from 113 Brazilian electronics firms by self-reported data. It was found that a green process and product innovation have a positive relation to a competitive advantage. His regression model showed the following result: R^2=0,219 and compared to this study there is a structure difference in the innovation model, as this study uses the traditional innovation model adapted for an environmental perspective (figure 16). On the other hand, green processes and product innovations is not differentiated in this work since it is not within the research objective to look at different behaviors in each type of innovation.

This study define GI as the effort in technology innovation using new processes and products that allows the Material Reduction (MR), Energy Reduction (ER), Water Reduction (WR) and Environment Impact (waste, pollution, etc) Reduction (EIR). This study thus constructs an Innovation output index based on the below PINTEC data, regarding the impact of innovation:

a) level of importance for material reduction;
b) level of importance for energy reduction/efficiency;
c) level of importance for water reduction;
d) level of importance for environmental impact reduction.

The final innovation model will be as the below figure.

Figure 16 – Green Innovation model adopted on this study



Source: Adapted by author (2016)

This study aims to study GI in Brazil, assessing the impact on the financial performance of the firms. This have been done using different methodologies from previous academic studies.

3 METODOLOGY

The study is based on a deductive reasoning and uses a quantitative methodology, by testing objective theories, examining the relation between variables (CRESWELL, 2009). The character of the study under consideration have been conducted with a positivist approach because the approach supports numerical measurement which is essential for the gathering of data relating to GI (input and output) and firm´s performance.

The main purpose of this study as previously mentioned is to investigate the impact of GI on the financial performance of firms. This have been achieved through the formulation of hypotheses as well as performing multiple linear regression in order to fully increase the understanding about the impact of innovation (input and output) on the financial performance of firms. Thus, the application of the procedures and principles of natural sciences will clearly indicate the relationship between innovation inputs (expenses) and outputs (environmental impact) on the firm's financial performance. This study aims to acquire knowledge relating to GI by conducting an empirical investigation to find out the impact on the financial performance of firms.

According to Babbie (1990), quantitative method will bring a numeric description of trend, attitude or opinions from a population. This approach is best to answer the study main question: Do Brazilian manufacturing firms that choose a green line of innovation perform financially different – compared to firms operating with conventional innovative strategies?, by clearing both positive or negative statement from previous research and confirming existing trend of increasing sustainable conscience which reflect on value added for consumers and contributing at organization competitive advantage.

The following hypothesis have been tested in the project:

a) H1 – Green Innovation have positive relation with superior sales Growth (ESTY; PORTER, 1998; PORTER; VAN DER LINDE, 1995; HALL, 1992);
   - H1a – Innovation related to reduction of material have positive relation with superior sales growth;
   - H1b – Innovation related to reduction of energy material have positive relation with superior sales growth;
   - H1c – Innovation related to Water reduction have positive relation with superior sales growth;

– H1d – Innovation related to Enviromental impact have a positive relation with superior sales growth.

b) H2 – Green Innovation have a positive relation with superior profitability.(PORTER, 1991; HART, 1995; PORTER;VAN DER LINDER, 1995; HENRIQUES; SADORSKY, 1996);

– H2a – Innovation related to reduction of material have positive relation with superior profitability;

– H2b – Innnovation related to reduction of energy material have positive relation with superior profitability;

– H2c – Innovation related to Water reduction have positive relation with superior profitability;

– H2d – Innovation related to Enviromental impact have a positive relation with superior profitability.

c) H3 – Green innovation have a positive relation with superior financial performance. (PORTER,1991; HART, 1995; PORTER; VAN DER LINDE, 1995; SCHMIDHEINY, 1992).

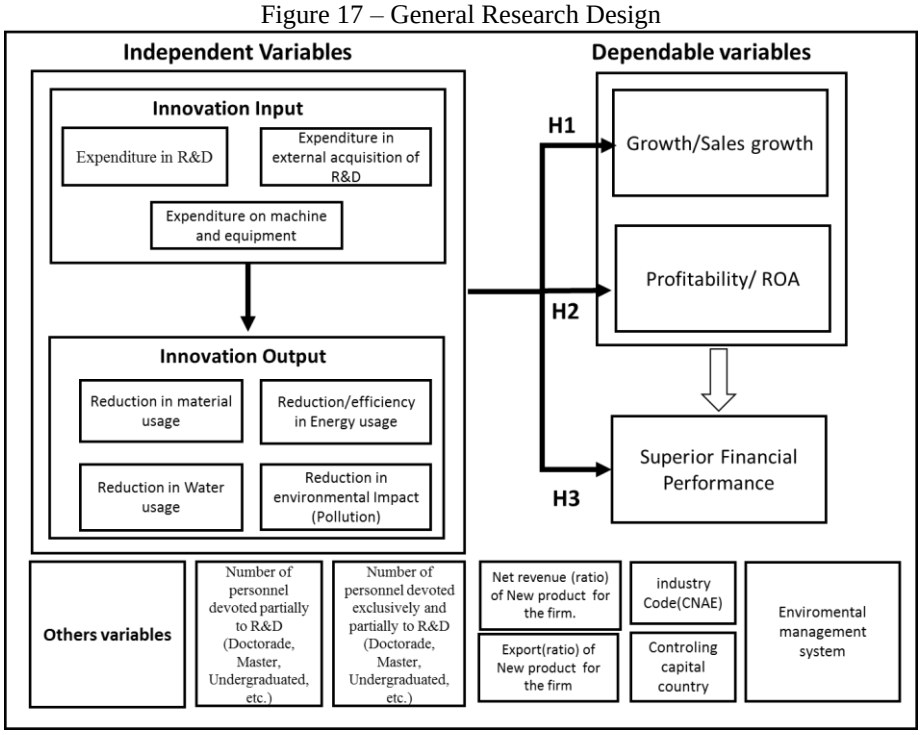
– H3a – Innovation related to reduction of material have positive relation with superior financial performance;

– H3b – Innnovation related to reduction of energy material have positive relation with superior financial performance;

– H3c – Innovation related to Water reduction have positive relation with superior financial performance;

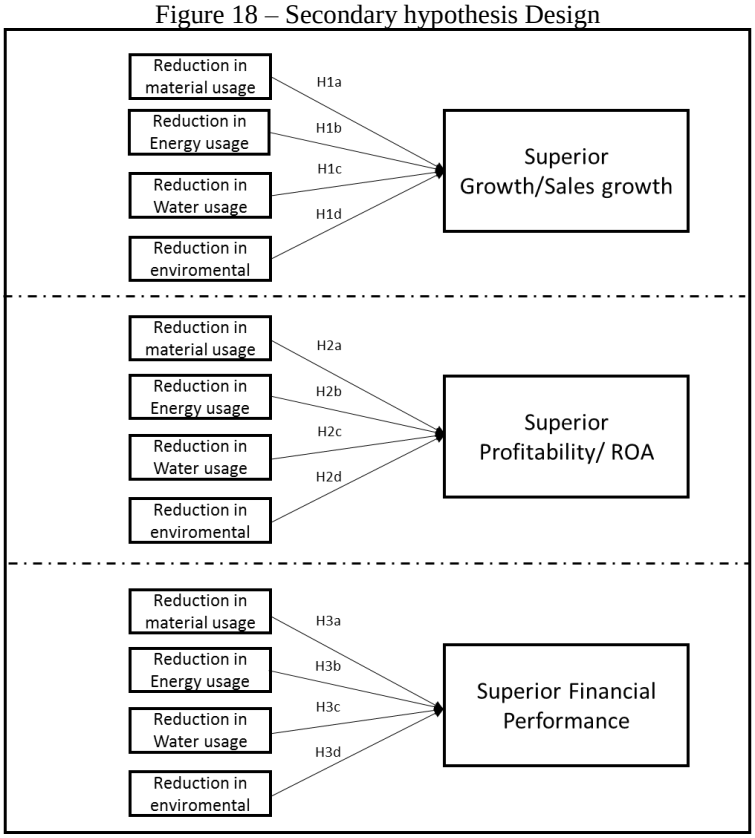
– H3d – Innovation related to Enviromental impact have a positive relation with superior financial performance.

Figure 17 – General Research Design



Source: Self elaboration (2017)

Figure 18 – Secondary hypothesis Design



Source: Self elaboration (2017)

H1, H2 and H3 are based on the GI model illustrated in the last chapter that included R&D expenditures as the innovation input the most commonly input seen in the literature

review and innovation/environmental output (MR, ER, WR and EIR). The secondary hypothesis (H1abcd, H2abcd and H3abcd) is aiming to enrich the analysis and to provide an answer to the secondary question.

Before conducting the analysis, a data treatment is necessary to summarize a large number of variables, for this purpose, a cluster analysis is used on two groups of variables; R&D expenditures and R&D personnel (by level of education).

Finally, to achieve the main objective of this study, evidencing the relationship between GI and financial performance the Multiple linear regression (MONTGOMERY, 2000) is used to find this evidence. This method attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to the observed data. This is the most common method seen in literature reviews (RUSSO; FOUTS, 1997; HAMILTON, 1995; COHEN et al., 1995; HART; AHUJA, 1996).

In the regression models, variables have been analyzed considering a certain level of statistical significance 5% The term statistical significance means that a result from testing or experimenting is not likely to occur randomly or by chance, but is instead likely to be attributable to a specific cause. The level of significance itself does not support reasoning about the probabilities of the hypotheses, but is rather a tool for deciding whether or not to reject the null hypothesis.

To ensure the accuracy of the regression analisys it have been performed normality test and collinearity test. The Normality test is a prerequisite for many statistical tests. The test investigates whether a sample follows a known probability distribution, or if any of the comparisons of the data to the population parameters are not valid. The colinearity test is made by analisining the VIF, this would show the presence of multicollinearity between the predictor of the regression. Value of the VIF above 10 indicate that the degree of the collinearity is a problem (HAIR et al., 1998). Fox and Weisberg (2011) argue that VIF cannot be use if there is variables with more than one degree of freedom (such as categorical variable with more than two level) recommending to use the GVIF in these cases, which is a corrected BIF by the number of freedom level of that variable: GVIF = VIF[1 / (2 * df)]. GVIF will be calculated for Clusters and Industry code (CNAE).

3.1 Population and sample collection

The data collected can usually be classified as primary data and secondary data. Primary data refers to data that a researcher has collected by himself either through the use of his own questionnaires, interviews, observations and so on. On the other hand, secondary data refers to data that others have already collected and it can come from various sources such as research articles, annual reports and government publications (Gratton & Jones, 2010, p. 73). In this study, secondary data has been used. This is because theoretical data relating to the R & D input, the Environmental output and the firm´s financial performance were collected from secondary sources. Moreover, when using secondary data to carry out researches in social sciences, the researcher has to ensure that the data to be collected is reliable, valid, current as well as checking whether the data has been used in other researches by prior researchers (Gratton & Jones, 2010, p. 73). Likewise, in this study, the empirical data that has been extracted from the PINTEC (2014) and PIA (2011 and 2014) is self-reported and not audited information, therefore a further validation have been necessary.

This study focus on Brazilian manufacturing firms, using two surveys to construct the database needed for the analysis.

The PINTEC survey, is a survey made by the IBGE, to study the innovation in the Brazilian manufacturing industry. The survey is supported by Brazilian law and is mandatory to every public and private Brazilian firm. The survey is published every 3 years and its statistical method is from the Oslo Manual, 3rd edition, 2005, from OECD. The survey reaches Brazilian Manufacturing firms, from the transformational to the extractive industry, including the electric and service (related to technology) sector. Within this universe, data from 17.171 firm was collected (PINTEC, 2014). This study use the data collected in this survey relating to innovation inputs and outputs and environmental impact data. For this study purpose, only the transformational industry is considered in the initial scope.

The PIA is an annual survey made by the IBGE, to monitor the Brazilian manufacturing industry. This study use the 2011 and 2014 survey to show the financial effects of innovation. In 2014, according to PIAs definition of what are active manufacturing firms, there were an estimated number of 334.752 firms in the Brazilian transformational and extractive industry. In 2014, data was collected from56.273 firms (PIA, 2014) and in 2011 data was collected from 55.814 firms' (PIA,2011).

A matching process was necessary, using the firms CNPJ (equivalent to Brazilian firm tax code), to validate, since a firm must have data in the 3 surveys simultaneously (2014 PINTEC, 2011 and 2014 PIA).

The samples have been classified by the industry code (CNAE), to avoid misleading analyses, since every industry possesses a very different technological intensity, profitability, and growth as explained in the previous literature review. The classification is illustrated on ANNEX 4.

When conducting this study the data has been validated with two conditions: Firstly, firms that have implemented an innovation within 2012 to 2014 and with a reported revenue above R$3.600.000. The first condition is justified by the study scope, which is innovation. The revenue condition, based on the Brazilian small company definition (below R$3.6000.000) is to avoid two problems: i) a nonlinear relationship that might disturb the relationship, since previous studies show that firms that did not have an environmental policy were among the low financial performers (MORHARDT, 2009), while medium financial performers had often adopted environmental policies (STANWICK; STANWICK, 2000) ii) invalid financial data, since several small firm either had not informed or informed wrongly regarding their assets, making the rentability/ROA calculation inaccurate. Resulting in a 4545 sample size.

To gain access to this secondary database, the analysis was conducted in a monitored data room, designated by IBGE, in Rio de Janeiro. The regression model and descriptive statistic was run on two statistic softwares: the SAS (version 9.3) and the STATA (version 12) considering a level of statistical significance of 5%. The analysis was run between April the 10th and April the 13th, 2017. The descriptive statistic do not possess a minimum and maximum value due to the non-disclosure rules established by the IBGE, as a consequence some statistical data and analysis was not available.

3.2 Variables

The data collected for the project have been separated into three categories which are; dependent variables, Independent Variables and Other variables.

Table 10 - Used variable from PINTEC data base

Num	Description	Value	Survey	Name
	Dependent Variables			
1	Superior Growth/Sales Growth	=2014Net revenue/2011 Net revenue	PIA 2011	SSG
2	Superior Profitability/ROA	=Net profit/Total Asset	PIA 2011	SP
3	Superior Financial Performance	=Growth*0,5+Profitability*0,5	PIA 2011	PSF
	Independendent Variables			
4	The Innnovation's level of importance to reduce Raw material consumption.	Qual (important=1/non important=0)	PINTEC 2011	MR
5	The Innnovation's level of importance to reduce energy consumption.	Qual (important=1/non important=0)	PINTEC 2011	ER
6	The Innnovation's level of importance to reduce water consumption.	Qual (important=1/non important=0)	PINTEC 2011	WR
7	The Innnovation's level of importance to reduce environmental impact(waste).	Qual (important=1/non important=0)	PINTEC 2011	EIR
8	Expenditures (ratio) in R&D	Quant(BRL)/Revenue(BRL)	PINTEC 2011	Turn to cluster
9	Expenditures (ratio) in External Adquisition of R&D.	Quant(BRL)/Revenue(BRL)	PINTEC 2011	Turn to cluster
10	Expenditures (ratio) in Adquisition new machines and equipment.	Quant(BRL)/Revenue(BRL)	PINTEC 2011	Turn to cluster

Source: Self elaboration (2017)

When collecting the environmental data the firms had to classify the effect of the innovation on the environment choosing between the following four answers: High, Medium, Low or Non relevant. This study then treated the data forming two groups: Important (High/medium) and non-important (Low/non) in order to clearly separate the environmental importance of the innovation.

To enrichen the study, several other variables have been included either for a descriptive analysis or in order to check the relationship with other inputs or outputs mentioned in the literature review. The variables are included below.

Table 11- Used variable from PINTEC data base

Num	Description	Value	Survey	Name
	Other Variables			
11	Industry Code	Qual (industry classification by IBGE)	PINTEC 2011	CNAE
12	Capital control Origin (country)	Qualitative (National=1 Foreign=2 Nat. and For.=3)	PINTEC 2011	Control Cap
13	Enviromental Management System	Qualitative (Yes=1 No=2)	PINTEC 2011	Env. Mang Syst.
14	Net revenue (ratio) of New product for the firm.	Quant(BRL)/Revenue(BRL)	PINTEC 2011	New revenue1
15	Net revenue (ratio) of New product for the firm, and in the Domestic market	Quant(BRL)/Revenue(BRL)	PINTEC 2011	New revenue 2
16	Net revenue (ratio) of New product for the firm and in the global market.	Quant(BRL)/Revenue(BRL)	PINTEC 2011	New revenue 3
17	Export (ratio) of New product for the firm.	Quant(BRL)/Revenue(BRL)	PINTEC 2011	New export 1
18	Export (ratio) of New product for the firm, and in the Domestic market	Quant(BRL)/Revenue(BRL)	PINTEC 2011	New export 2
19	Export (ratio) of New product for the firm and in the global market.	Quant(BRL)/Revenue(BRL)	PINTEC 2011	New export 3
20	Number of personnel devoted exclusively on R&D, with doctorade degree.	Quant(head count)	PINTEC 2011	Turn to cluster
21	Number of personnel devoted exclusively on R&D, with Master degree.	Quant(head count)	PINTEC 2011	Turn to cluster
22	Number of personnel devoted exclusively on R&D, with undergraduated degree.	Quant(head count)	PINTEC 2011	Turn to cluster
23	Number of personnel devoted exclusively on R&D, below undergraduated degree.	Quant(head count)	PINTEC 2011	Turn to cluster
24	Number of Technician devoted exclusively on R&D with undergraduate degree	Quant(head count)	PINTEC 2011	Turn to cluster
25	Number of Technician devoted exclusively on R&D with belowundergraduate degree	Quant(head count)	PINTEC 2011	Turn to cluster
26	Number of personnel devoted partially on R&D, with Doctorade degree.	Quant(head count)	PINTEC 2011	Turn to cluster
27	Number of personnel devoted partially on R&D, with Master degree.	Quant(head count)	PINTEC 2011	Turn to cluster
28	Number of personnel devoted partially on R&D, with undergraduated degree.	Quant(head count)	PINTEC 2011	Turn to cluster
29	Number of personnel devoted partially on R&D, with below undergraduated degree.	Quant(head count)	PINTEC 2011	Turn to cluster
30	Number of Technician with undergraduate degree on R&D	Quant(head count)	PINTEC 2011	Turn to cluster
31	Number of technician below undergraduate degree on R&D	Quant(head count)	PINTEC 2011	Turn to cluster
32	Other Assistance personnel devoted exclusively	Quant(head count)	PINTEC 2011	Turn to cluster
33	Other Assistance personnel devoted partially	Quant(head count)	PINTEC 2011	Turn to cluster

Source: Self elaboration (2017)

3.3 Data treatment

The data related to R&D expenditures and personnel have been summarized with one variable for each, by using a Cluster analysis (JOHNSON & WICHERN, 2007). This method has the objective to put elements of the sample into homogenic groups, while simultaneously maintaining these groups heterogeneous. For this analysis, the study follows Malhotra (2006) suggestion, using a hierarchical procedure followed by a non-hierarchical grouping. The explanation is that plain hierarchical methods are also poorly equipped to handle complex scenarios as discussed by Liao (2005), because they cannot make adjustments once a merge or split action has been performed, leading to poor scenario structures. The result should be a dendogram, which is a type of tree diagram, frequently used to illustrate the arrangement of the clusters produced by hierarchical method. Dendrograms graphically represent the information of observations that are grouped together at various levels of (dis)similarity. At the bottom of the dendrogram, each observation is considered its own cluster (STATA, 2011).

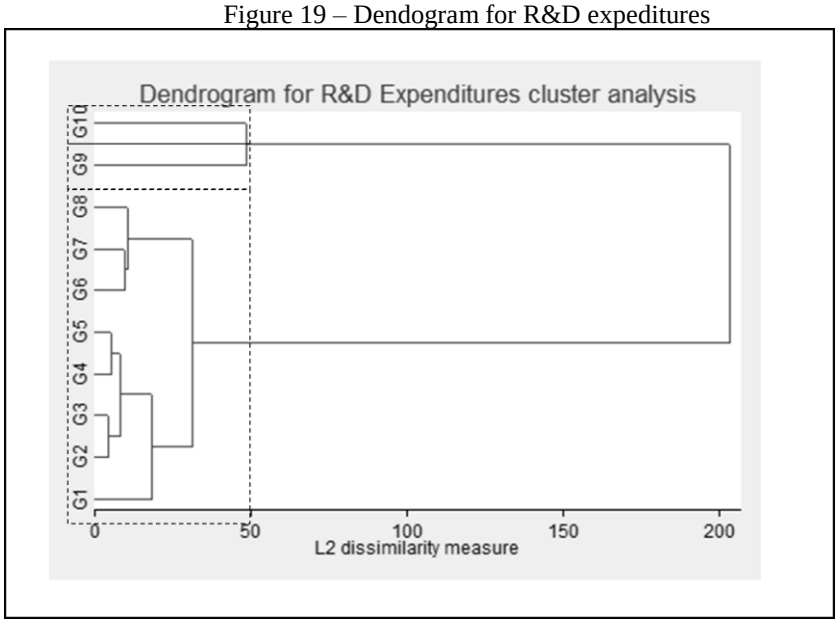
Following Malhora(2006) instruction, Ward's method has been chosen as it's one of the best methods and it is commonly used for hierarchical grouping methods (MALHOTRA, 2006; KUBRUSLY, 2001). In order to verify the formed group, a k-medians method has been used in order to build a group of firms, with the same variables used previously. For the grouping three groups were chosen from the dendrogram below. The results from the three groups is illustrated in the below figure. The grouping process is based on the statistical distances between the groups. Inside these groups, the firms have similar characteristics but when comparing the groups it appears that there are larger characteristic differences. Brusco and Kohn (2009) and Kohn et al (2010) state that the k-median method is similar to the k-means, but it uses medians, and not means, to determinate the cluster centroid, and when looking at the similarities, it uses the Manhattan distance instead of the Euclidian distance. The chosen method is therefore the most appropriate for this study since the data distribution is not symmetric, and the means do not represent the data in as efficient a way as the medians do.

From the cluster analisys, it have been defined the following variables:

a) R&D Expenditures (variable nº 8 to 10), forming 3 groups;
b) R&D personnel (variable nº 20 to 30), forming 3 groups.

3.3.1 R&D expenditures cluster

Figure 19 – Dendogram for R&D expeditures



Source: Self elaboration (2017)

The R&D expenditure cluster analysis have form 3 final group: kmedian3expen1, kmedian3expen2 and kmedian3expen3. Having the following distribution 13.5%, 5.5% and 81%. kmedian3expen1 is form by firm with moderated technological intensity (R&D Expenditure/Revenue) but having highest mean SP and SFP. kmedian3expen2 is form by group of firm being more technology intensive and possess the highest mean SSG. kmedian3expen3 is composed by firm with low R&D expenditure and have low mean SSG, SP and SFP.

Table 12- Descriptive statistic from R&D expenditure Cluster

(to be continue)

kmedian3expen1					13.5%
Variable	**Mean**	**Std Dev**	**Lower Quartile**	**Median**	**Upper Quartile**
Internal R&D	1.22%	0.0340	0.000%	0.00%	0.902%
External R&D	0.16%	0.0080	0.000%	0.00%	0.000%
Mach. and Equip.	4.44%	0.0193	2.714%	4.08%	5.690%
SSG	1.1031	0.3157	0.9065	1.0602	1.2945
Sales Growth	1.3668	0.4156	1.0972	1.2920	1.5963
SP	1.5297	3.0097	0.0005	1.4591	3.1220
Profitability	0.0637	0.1307	0.0000	0.0565	0.1319
SFP	1.4234	1.4896	0.5900	1.3192	2.1780

(conclusion)

kmedian3expen2 5.5%

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Internal R&D	3.26%	0.2178	0.000%	0.00%	0.500%
External R&D	0.11%	0.0041	0.000%	0.00%	0.000%
Mach. and Equip.	105.38%	7.8447	11.000%	14.06%	20.065%
SSG	1.1447	0.3993	0.8640	1.0694	1.3674
Sales Growth	1.4214	0.5093	1.0589	1.3217	1.7228
SP	1.1829	3.2840	-0.2437	1.2195	3.2824
Profitability	0.0572	0.1355	-0.0091	0.0552	0.1254
SFP	1.3949	1.4904	0.4628	1.3568	2.3958

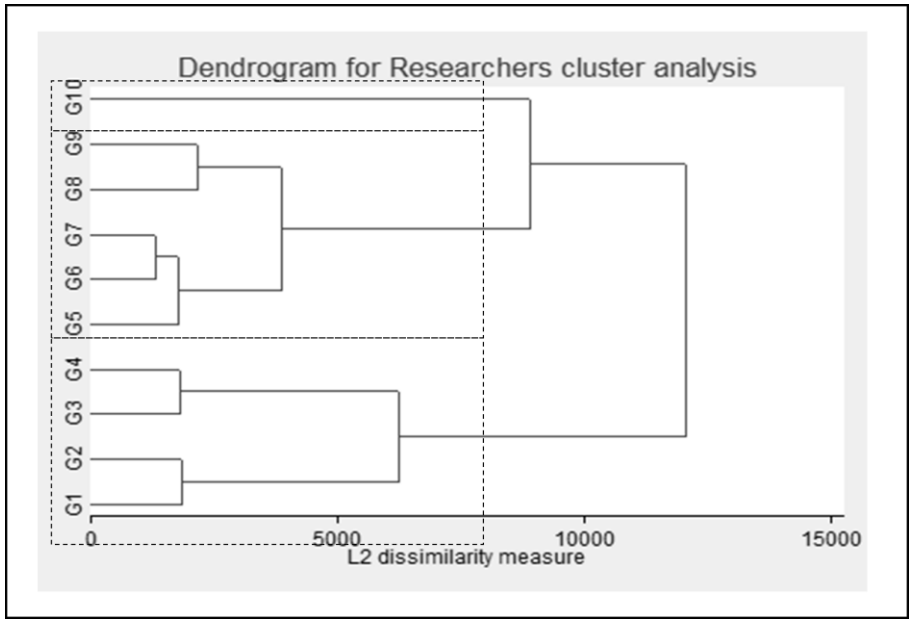
kmedian3expen3 81.0%

Variable	Mean	Std Dev	Lower Quartil	Median	Upper Quartile
Internal R&D	0.78%	0.0810	0.000%	0.00%	0.316%
External R&D	0.08%	0.0074	0.000%	0.00%	0.000%
Mach. and Equip.	0.20%	0.0044	0.000%	0.00%	0.087%
SSG	1.0445	0.3257	0.8413	1.0115	1.2072
Sales Growth	1.3027	0.4220	1.0327	1.2564	1.5274
SP	1.2123	3.0995	-0.1979	1.0630	2.7515
Profitability	0.0568	0.1359	-0.0083	0.0455	0.1206
SFP	1.2866	1.4801	0.4321	1.1182	2.0331

Source: Self elaboration (2017)

3.3.2 R&D personnel cluster

Figure 20 – Dendogram for R&D personnel



Source: Self elaboration (2017)

The R&D personnel cluster analysis have form 3 final group: *kmedian3resear1, kmedian3resear2 and kmedian3resear3*. Having the following distribution 5.87%, 93.76% and 0.37%. *kmedian3resear1* is form by firm with moderated quantity of R&D personnel (Head count from part and full time) but having highest mean SSG. *kmedian3expen2* is form by group of firm low quantity of R&D personnel with highest mean SP and SFP. and possess the highest mean SSG. *kmedian3expen3* is composed by firm with high quantity of R&D personnel and have inferior mean SSG, SP and SFP whenever compared with the other 2 cluster.

Table 13- Descriptive statistic from R&D personnel Cluster

(to be continue)

kmedian3resear1 5.87%

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Excl_doctor	2.73	7.21	0	0	2
Excl_Master	6.20	9.17	1	3	8
Excl_under	54.85	50.71	23	33	60
Excl_belowunder	8.46	18.85	0	0	6
Excltech_under	8.49	20.47	0	0	10
Excltech_belowunder	8.29	16.35	0	0	9
Excl_Assist	6.06	20.38	0	0	4
Part_doctor	0.21	0.93	0	0	0
Part_master	1.21	6.09	0	0	0

(to be continued)

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Part_under	10.58	30.09	0	0	1
Part_below under	2.61	13.85	0	0	0
Parttech_under	2.37	11.92	0	0	0
Parttech_belowunder	3.22	12.90	0	0	0
Part_assist	3.55	23.94	0	0	0
SSG	1.0646	0.3088	0.8867	1.0256	1.2278
Sales Growth	1.316	0.4131	1.057	1.266	1.554
SP	1.1892	2.7832	-0.0498	1.4846	2.6293
Profitability	5.85%	0.1116	-0.07%	6.26%	12.98%
SFP	1.2149	1.3482	0.4794	1.3646	1.8970
kmedian3resear2					93.76%

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Excl_doctor	0.09	0.54	0	0	0
Excl_Master	0.22	0.94	0	0	0
Excl_under	1.31	2.89	0	0	1
Excl_belowunder	0.41	2.53	0	0	0
Excltech_under	0.83	5.12	0	0	0
Excltech_belowunder	0.85	8.86	0	0	0
Excl_Assist	0.47	5.44	0	0	0
Part_doctor	0.04	0.53	0	0	0
Part_master	0.17	1.47	0	0	0
Part_under	1.95	12.71	0	0	0
Part_below under	0.94	16.26	0	0	0
Parttech_under	1.14	7.89	0	0	0
Parttech_belowunder	1.12	8.17	0	0	0
Part_assist	0.73	7.06	0	0	0
SSG	1.0575	0.3314	0.8521	1.0201	1.2221
Sales Growth	1.3185	0.4284	1.0456	1.2655	1.5473
SP	1.2643	3.1133	-0.1573	1.0848	2.8729
Profitability	5.79%	0.1367	-0.73%	4.58%	12.25%
SFP	1.3192	1.4903	0.4461	1.1393	2.0889
kmedian3resear3					0.37%

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Excl_doctor	7.60	10.55	1	3.5	10
Excl_Master	75.50	110.85	8	27	73
Excl_under	966.10	955.47	470	575	667
Excl_belowunder	56.00	61.92	4	34.5	75
Excltech_under	50.00	118.37	0	0	35
Excltech_belowunder	35.80	68.05	0	0	35
Excl_Assist	9.20	19.54	0	0	3
Part_doctor	0.30	0.95	0	0	0
Part_master	4.80	10.22	0	0	0
Part_under	123.30	204.38	0	0	314
Part_below under	140.00	295.75	0	0	0
Parttech_under	0.00	0.00	0	0	0
Parttech_belowunder	36.00	96.96	0	0	0
Part_assist	41.40	130.92	0	0	0
SSG	0.9588	0.1388	0.8559	0.9491	1.0614
Sales Growth	1.0694	0.1980	0.9721	1.0543	1.1841

(conclusion)

Variable	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
SP	-0.0553	3.9320	-2.0611	0.5762	2.8696
Profitability	1.30%	0.0730	-3.03%	1.89%	6.80%
SFP	0.8913	1.5090	0.2493	1.2584	1.9207

Source: Self elaboration (2017)

3.4 Data analysis

To achieve the main objective of this study, which is to analyze the relationship between GI and financial performance, this study perform multiple linear regressions (MONTGOMERY, 2000). The dependent variables used are created from the following equation:

$$Y1=\frac{\text{net sales } 2014/\text{net sales } 2011}{\text{median growth by CNAE}}=\frac{\text{sale growth}}{\text{median growth by CNAE}}=\text{Superior Sales Growth}$$

$$Y2=\frac{\text{profit14}/\text{asset2014}}{\text{median ROA by CNAE}}=\frac{\text{ROA}}{\text{ROA median by CNAE}}=\text{Superior Profitability}$$

$$Y3=(\text{ROA relative}*0.5)+(\text{Growth relative}*0.5)=\text{superior financial performance}$$

The other variables used on the regression model are: the relationship between the variable of WR (X1), ER (X2), MR (X3) and EIR (X4) with the SSG (Y1), SP (Y2) and SFP (Y3) were analyzed. This study also included other variables in the regression models, for the purpose of adjustment, according to the literature, these variables are strategical resources that can impact a firms performance: “R&D expenditures cluster” (X5), “R&D personnel cluster” (X6), “Control capital origin” (X7), “CNAE” (X8) (two digit), “environmental management system” (X9), “Net revenue (ratio) of New products for the firm” (X10), “Net revenue (ratio) of New products for the firm, and in the Domestic market” (X11), “Net revenue (ratio) of New products for the firm and in the global market” (X12), “Export (ratio) of New product for the firm” (X13), “Export (ratio) of New products for the firm, and in the Domestic market” (X14),

“Export (ratio) of New products for the firm and in the global market” (X15). Using all these variables the result of the regression equation can be seen below.

$$Y1=\alpha+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\ldots+\beta15X15+\varepsilon$$
$$Y2=\alpha+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\ldots+\beta15X15+\varepsilon$$
$$Y3=\alpha+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\ldots+\beta15X15+\varepsilon$$

Where α is the intercept, β’s are the coefficient of the regression and ε is the error.

In the model, it have been tested all normality and homoscedasticity of the residual through appropriate graphics analisys (histogram, normal-plot and dispersion graphics).

4 RESULT ANALYSIS AND DISCUSSION

The data collected has been analyzed and the results will now be presented and discussed in this chapter. The objective of the study has been reviewed during this analysis, to enable the final discussion of the result. The first part describes the Brazilian manufacturing industry followed by a descriptive analysis of the sample.

4.1 Manufacturing industry overview and descriptive analisys

This topic will show an overview of the manufacturing firms, which will help to understand the scope of this study. Later on, the profile of each firm participating in each of three regression models will be analyzed. Each model have a different sample size.

4.1.1 Manufacturing industry overview

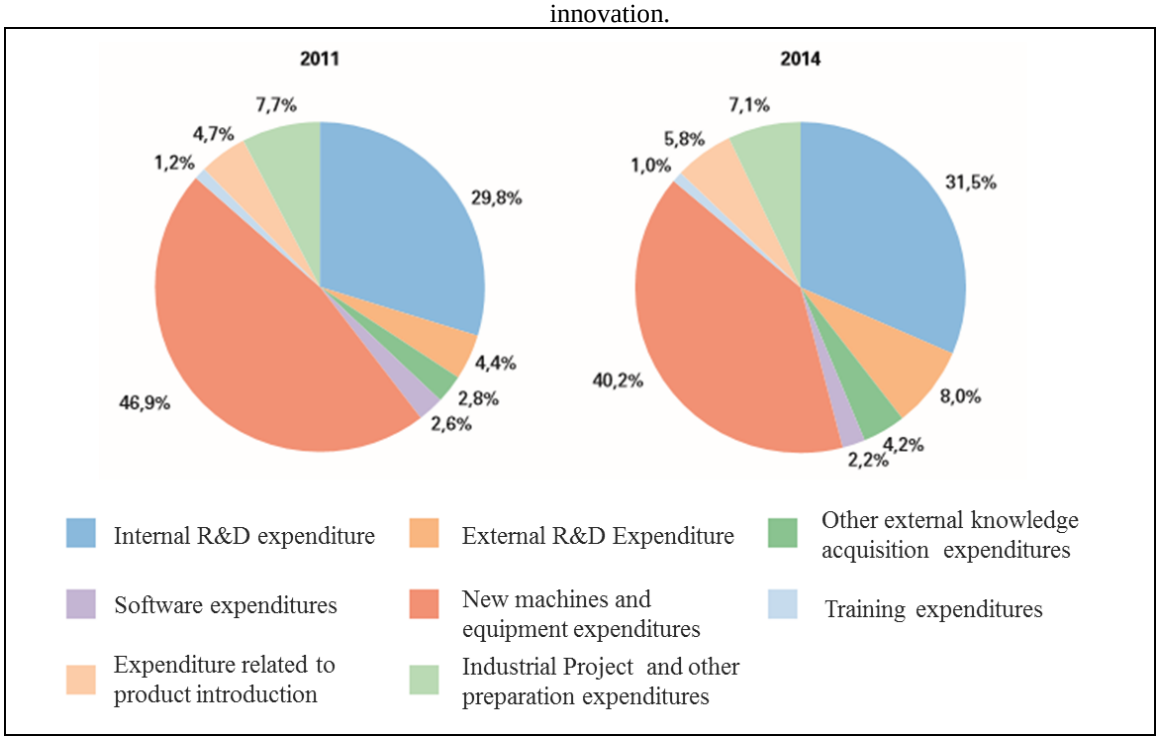
According to the IBGE (2016) classification system, the Brazilian manufacturing industry is mainly distinguished by using the CNAE code, which is a two digit Code from 10 to 33, resulting in 34 different industries/sectors/markes: *Food Product manufacturing, Beverage product Manufacturing, Tobacco Product manufacturing, Textile Product manufacturing, cloth and accessories product manufacturing, Footwear/Leather related/ Travel equipment manufacturing, Wood product manufacturing, Cellulose and paper industry manufacturing, Printing and recording product manufacturing, materials derived from crude oil and Biofuels manufacturing, chemical product manufacturing, Pharmaceutical and Farm chemical product manufacturing, Rubber and plastic product manufacturing, non-mineral product manufacturing, metallurgy product manufacturing, Metal made product (non-machine and equipment) manufacturing, optical/electronical/electrical product manufacturing, electrical machines/devices manufacturing, Machines and equipment manufacturing, Automotive manufacturing, other transportation equipment (non-auto) manufacturing,*

furniture manufacturing, other diverse product manufacturing, and last, maintenance/reparation of machine and equipment. Illustrated in Annex 4.

A discussion regarding the significant role of innovation, when maintaining and improving the competitiveness of the national products, especially considering the manufacturing firms has surfaced during the last decade in Brazil in the political field. An important step was taken when an investment fund was created to support the industrial R&D investment, this was done through the constitution of the innovation law (10.973/2004) and the Asset law (11.196/2005), which helped to constitute a partnership between the universities, the technological institutions and the firms. This provided a tax benefit to firms that invested in RD&I (Research, development and Innovation).

Despite the governmentally created incentive, the Brazilian scenario is still pessimistic: PINTEC (2014) shows that only 16.6% of the manufacturing firm have a R&D department as a source of their innovation. Also, most innovation has been predominantly introduced by the acquisition of new machines and equipments (40,2%), as illustrated in the below figure.

Figure 21 – type of Expenditure for innovative activities, from those who performed process or product innovation.



Source: IBGE, PINTEC 2014

In 2014 most innovation by Brazilian manufacturing firms, by introduced by large companies. The data shows that the innovation rate for firms with a head count above 500 is 65.7% but when looking at all manufacturing firms this proportion drops to 36.4% (PINTEC 2014).

Between 2012 and 2014, 32.4% manufacturing firms implemented an innovation (product and/or process), 27.7% produced a Process innovation and 20.6% produced a product innovation (PINTEC 2014).

When conducting a deeper analysis, it can be seen that the Technological intensity is different for each industry. The OECD classifies the industries into four categories which depend on the industry technological intensity (according to the OECD definition, this is defined by looking at the total Internal R&D expenditures/Value added): High technological intensity, Middle high technological intensity, Middle low technological intensity and Low intensity. These are illustrated in detail in the below table.

Table 14 – OECD industry classification base on technology intensity.

OECD Classification	**Industry**
High technology Intensive	Aero-spacial ; pharmaceutical; Informational Technology; electronics and telecommunication; instruments;
Middle high Technology intensive	electric product; automotive ; Chemical (non pharmaceutical); Railway and transportation industry; machine and equipment;
Middle low technology intensive	Naval construction; rubber and plastic product; metallurgic coke and by product from crude oil and nuclear combustible ; other non metallic product; metallurgic and other metallic product.
Low technology intensive	Other sector and recycling sector; wood, paper and cellulose; Printing and editing; Food, Beverage, tobacco; textile and confection, leather and footwear.

Source: OECD 2014

Furtado and Carvalho (2005) argue that this classification is not accurate for the Brazilian industry, since the OECD classification is mainly based on the behavior in developed countries. This is illustrated in the below table.

Table 15 –% of total expenditures of Brazil industry, base on OECD Technology intensity classification, Brazil and selected countries.

OECD Classification	Canada	USA	Japan	Korea	France	Germany	Italy	Norway	Spain	Brazil
	2001	2000	2000	2000	1999	2000	2001	1998	2000	2000
High technology Intensive	80.03	61.63	44.32	60.93	54.38	34.06	59.73	43.75	43.41	25.31
Middle high Technology intensive	9.84	28.97	41.68	28.08	32.32	58.05	38.81	29.04	33.92	40.11
Middle low technology intensive	4.99	4.78	8.63	6.93	9.22	5.59	4.85	16.73	10.93	20.97
Low technology intensive	5.29	4.47	5.37	4.18	4.08	2.3	2.61	10.29	11.74	12.28

Source: OECD (2002); IBGE (2002), PINTEC 2000. In Furtado and Carvalho (2005).

Many earlier authors (KATZ, 1976; BELL, 1984; LALL, 1982) state that developing countries were merely technology importers, buying the technology from developed countries. This scenario changed with the Brazilian national effort. In a more recent study, Furtado and Carvalho (2005) state that firms with foreign controlled capital do not invest much in local internal R&D, as these multinational firms have access to technology that is develop in other R&D centers around the world.

According to the authors, in 2000 the brazilian Average technological intensity (R&D/added value) was 1.5%, against 8.3% from USA, 8.6% from Japan, 4.5% from korea, 4.0% from Canada, 7.0% from France, 7.4% from Germany, 2.1 from Italy, 2.1 from Spain and 4.3% from Norway. They furthermore state that the only high technological intensity sector in Brazil is the Electric equipment and product industry with 4.2% of the technological intensity, which is a percentage very similar to what many developed country has. This sector contains a great proportion of the multinational companies, but demands a high cost when it comes to technological adaptations making the local R&D a necessity. Two other sectors with a high technology intensity are the electronics products and Other transportation equipment (non-automotive), but these still fall behind compared to developing countries when it comes to technology intensity.

According to PINTEC (2014), the three most commonly attributed impacts by innovation have been: a) it allows the firm to maintain market shares; b) It raises the product or the service quality and c) It raises the capacity of the production or the service. And a less commonly attributed impact is the innovation impact on the water Reduction. The survey

classified the type of innovation impact by four levels of importance, high, medium, low or non-relevant. Please see this in the below table.

Table 16 –% firm replyed high/medium importance on each type of innovation impact

Innovation impact	% (High/Medium)
1.Allowed to maintain market share	81.50%
2.Raised the product or service quality	80.10%
3.Raised capacity on production or service	73.70%
4.Raised flexibility on production or service	71.80%
5.Allowed to gain market share	68.40%
6.Allow to control impact related to health and safety	59.80%
7.Allowed to reduce production cost or service cost	58%
8.Allowed to reduce labor cost	56.80%
9.External or Internal market regulation adequation	51.30%
10.Raised quantity of product or service offered	42%
11.Allowed to reduce Environmental impact (pollution/waste)	41.80%
12.Allowed to open new market	37%
13.Allowed to reduce material Consumption	34.10%
14.Allowed to reduce Energy Consumption	28.40%
15.Allowed to reduce Water Consumption	19.50%

Source: PINTEC 2014.

4.1.2 Descriptive analisys

Descriptive statistics have been made for each of the three regression models. Each model has a different sample size, due to two data validating conditions, added after analyzing

the data: SSG >2.2 will not be considered, SP >10 and <-10 will not be considered and SFP < -3 and > 6. These conditions have been placed in order to avoid outliers, between the manufacturing firms. These conditions exclude young firms with an exponential growth or failure, frequently having low assets (incompatible with the firms return) and a high return/negative return.

Initially, the data has been described as the absolute frequency and percentage of the qualitative variable. And later on, it will be described through means, medians and quartiles for quantitative variables.

Looking on the descriptive for SSG model descriptive, data seem to show that firms that performed MR, ER, WR and EIR have less SSG (mean and median). At first sight, This seem to show a different result as the literature. The lower(MR, WR and EIR) and upper quartile(for WR), for green innovator does seem to be highier in some case.

Table 17 – SSG descriptive statistic.

(to be continued)

MR	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SSG	1664	1.0608	0.3354	0.8466	1.0186	1.2234
	Growth	1664	1.3280	0.4360	1.0444	1.2676	1.5531
High/Middle	SSG	932	1.0519	0.3191	0.8570	1.0233	1.2140
	Growth	932	1.2984	0.4103	1.0462	1.2571	1.5253

ER	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SSG	1705	1.0583	0.3317	0.8485	1.0215	1.2238
	Growth	1705	1.3228	0.4278	1.0456	1.2710	1.5473
High/Middle	SSG	891	1.0561	0.3258	0.8582	1.0178	1.2131
	Growth	891	1.3070	0.4257	1.0425	1.2502	1.5411

WR	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SSG	1898	1.0515	0.3234	0.8434	1.0147	1.2149
	Growth	1898	1.3101	0.4189	1.0336	1.2598	1.5409
High/Middle	SSG	698	1.0741	0.3455	0.8742	1.0424	1.2445
	Growth	698	1.3373	0.4483	1.0779	1.2785	1.5566

(to be continued)

EIR	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SSG	1375	1.0491	0.3204	0.8387	1.0188	1.2196
	Growth	1375	1.3120	0.4160	1.0440	1.2715	1.5468
High/Middle	SSG	1221	1.0672	0.3396	0.8633	1.0215	1.2261
	Growth	1221	1.3235	0.4393	1.0464	1.2565	1.5466

CNAE	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
10	SSG	384	1.0680	0.3345	0.8625	1.0314	1.2358
	Growth	384	1.5455	0.4841	1.2482	1.4927	1.7884
11	SSG	47	1.0673	0.3454	0.8306	1.0016	1.3246
	Growth	47	1.4528	0.4701	1.1306	1.3633	1.8029
12	SSG	4	1.1312	0.2321	0.9702	1.0784	1.2921
	Growth	4	1.2490	0.2563	1.0713	1.1907	1.4268
13	SSG	119	0.9818	0.3031	0.8081	0.9678	1.1057
	Growth	119	1.1845	0.3657	0.9750	1.1676	1.3340
14	SSG	97	1.0771	0.3037	0.8729	1.0583	1.2621
	Growth	97	1.3701	0.3863	1.1102	1.3462	1.6053
15	SSG	74	1.0246	0.3646	0.7751	0.9683	1.2116
	Growth	74	1.2732	0.4531	0.9631	1.2032	1.5055
16	SSG	40	1.0484	0.3278	0.8497	0.9968	1.2752
	Growth	40	1.3131	0.4105	1.0643	1.2486	1.5973
17	SSG	77	1.0385	0.2403	0.9330	1.0131	1.1485
	Growth	77	1.3162	0.3046	1.1825	1.2840	1.4556
18	SSG	29	0.9882	0.3978	0.7446	0.8968	1.0990
	Growth	29	1.1772	0.4739	0.8870	1.0683	1.3093
20	SSG	195	1.0792	0.2816	0.9215	1.0352	1.2328
	Growth	195	1.3669	0.3566	1.1671	1.3112	1.5615
21	SSG	63	1.0304	0.2555	0.8867	1.0301	1.1863
	Growth	63	1.4575	0.3614	1.2542	1.4571	1.6780
22	SSG	186	1.0339	0.3401	0.8194	0.9985	1.2046
	Growth	186	1.3056	0.4294	1.0348	1.2609	1.5212
23	SSG	123	1.0849	0.3059	0.9085	1.0442	1.2475
	Growth	123	1.2977	0.3659	1.0867	1.2490	1.4922
24	SSG	86	1.1210	0.3489	0.9021	1.0961	1.3369
	Growth	86	1.2411	0.3863	0.9988	1.2136	1.4801
25	SSG	178	1.0572	0.3408	0.8312	1.0416	1.2206
	Growth	178	1.2030	0.3878	0.9458	1.1851	1.3889
26	SSG	96	1.0979	0.3763	0.8315	1.0627	1.2703
	Growth	96	1.2768	0.4376	0.9670	1.2359	1.4773

(conclusion)

CNAE	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
27	SSG	122	1.0574	0.3239	0.8461	1.0239	1.1982
	Growth	122	1.2885	0.3947	1.0309	1.2476	1.4599
28	SSG	271	1.0792	0.3526	0.8464	1.0501	1.2933
	Growth	271	1.2612	0.4120	0.9891	1.2271	1.5114
29	SSG	164	1.0119	0.3301	0.7674	0.9614	1.1748
	Growth	164	1.0785	0.3518	0.8179	1.0247	1.2521
30	SSG	28	1.0704	0.4359	0.6851	1.0654	1.2827
	Growth	28	1.1957	0.4869	0.7654	1.1902	1.4329
31	SSG	115	1.0615	0.3451	0.8578	0.9925	1.1829
	Growth	115	1.3559	0.4409	1.0957	1.2678	1.5111
32	SSG	73	1.0305	0.2978	0.8434	0.9953	1.1753
	Growth	73	1.2856	0.3716	1.0521	1.2417	1.4662
33	SSG	25	1.0878	0.3442	0.9017	1.0449	1.3034
	Growth	25	1.3513	0.4275	1.1202	1.2980	1.6191

Source: IBGE (2016).

Looking on the descriptive for SP model descriptive, data seem to show that firms that performed MR, ER, WR and EIR have less SP (mean and median).

Table 18 – SP descriptive statistics.

(to be continued)

MR	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SP	1552	1.2953	3.1816	-0.1399	1.1351	2.9458
	Profitability	1552	5.84%	0.1363	-0.62%	4.83%	12.50%
High/Middle	SP	874	1.1818	2.9450	-0.2264	1.0724	2.7335
	Profitability	874	5.67%	0.1332	-0.86%	4.35%	11.61%

ER	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SP	1601	1.3032	3.1616	-0.0948	1.1199	2.9980
	Profitability	1601	6.09%	0.1417	-0.55%	4.81%	12.62%
High/Middle	SP	825	1.1597	2.9713	-0.2368	1.1078	2.6788
	Profitability	825	5.18%	0.1213	-0.87%	4.44%	11.56%

WR	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SP	1773	1.2723	3.1671	-0.1012	1.1258	2.8806
	Profitability	1773	5.85%	0.1409	-0.45%	4.77%	12.35%
High/Middle	SP	653	1.2057	2.9052	-0.2601	1.0791	2.7056
	Profitability	653	5.58%	0.1184	-0.99%	4.40%	11.85%

(to be continued)

EIR	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/non relevant	SP	1287	1.3283	3.1789	-0.0915	1.1228	3.0109
	Profitability	1287	6.18%	0.1414	-0.59%	4.79%	13.05%
High/Middle	SP	1139	1.1709	3.0039	-0.2264	1.0965	2.6884
	Profitability	1139	5.32%	0.1277	-0.83%	4.44%	11.45%

CNAE	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
10	SP	369	1.3744	2.6473	0.0031	1.0791	2.7078
	Profitability	369	6.36%	0.1225	0.01%	4.99%	12.53%
11	SP	44	1.8012	4.2034	0.1154	1.4602	4.2406
	Profitability	44	4.98%	0.1162	0.32%	4.04%	11.73%
12	SP	1	7.9992	.	7.9992	7.9992	7.9992
	Profitability	1	3.24%	.	3.24%	3.24%	3.24%
13	SP	113	0.6316	3.3633	-0.6299	0.7229	2.5336
	Profitability	113	2.20%	0.1171	-2.19%	2.52%	8.82%
14	SP	94	1.3984	2.0088	0.1044	1.1180	2.7637
	Profitability	94	13.70%	0.1969	1.02%	10.96%	27.08%
15	SP	76	1.0664	1.6233	0.0776	0.7820	1.6674
	Profitability	76	10.15%	0.1545	0.74%	7.44%	15.87%
16	SP	34	0.5798	2.7036	-0.0409	1.1908	1.8565
	Profitability	34	2.30%	0.1073	-0.16%	4.73%	7.37%
17	SP	70	2.3315	3.2297	0.0121	2.0127	5.2668
	Profitability	70	5.19%	0.0719	0.03%	4.48%	11.73%
18	SP	29	0.6540	2.4148	-0.1417	0.4471	1.0002
	Profitability	29	5.92%	0.2187	-1.28%	4.05%	9.06%
20	SP	187	1.5799	2.9210	0.0172	1.5467	3.2186
	Profitability	187	6.36%	0.1176	0.07%	6.22%	12.95%
21	SP	62	1.2093	2.3299	0.2382	1.6013	2.3342
	Profitability	62	10.74%	0.2068	2.11%	14.22%	20.72%
22	SP	158	1.1019	3.9179	-0.3714	1.2532	3.2440
	Profitability	158	3.28%	0.1167	-1.11%	3.73%	9.66%
23	SP	115	1.7288	2.8916	0.0696	1.3892	3.1417
	Profitability	115	7.03%	0.1175	0.28%	5.65%	12.77%
24	SP	70	1.3254	3.7869	-0.6704	1.3301	3.6201
	Profitability	70	2.02%	0.0577	-1.02%	2.03%	5.51%
25	SP	170	1.0010	3.2750	-0.3380	0.9435	2.6788
	Profitability	170	4.37%	0.1429	-1.48%	4.12%	11.69%
26	SP	96	1.2667	2.9859	-0.3901	0.9413	2.6156
	Profitability	96	6.43%	0.1517	-1.98%	4.78%	13.28%
27	SP	118	0.7894	3.5286	-0.7501	0.7472	2.6884
	Profitability	118	3.12%	0.1394	-2.96%	2.95%	10.62%
28	SP	265	1.3924	2.9176	0.0096	1.2638	2.8224
	Profitability	265	6.64%	0.1392	0.05%	6.03%	13.47%
29	SP	115	0.4772	4.4078	-2.6627	0.6146	3.3245
	Profitability	115	0.70%	0.0648	-3.91%	0.90%	4.89%
30	SP	29	0.7253	3.1292	-0.5326	0.7344	1.7580
	Profitability	29	2.27%	0.0977	-1.66%	2.29%	5.49%
31	SP	110	1.8115	3.1800	0.4288	2.1116	3.4702
	Profitability	110	5.66%	0.0993	1.34%	6.60%	10.84%
32	SP	74	0.9421	1.7139	-0.0922	0.6410	1.9610
	Profitability	74	7.93%	0.1443	-0.78%	5.40%	16.52%

(conclusion)

CNAE	Variable	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
33	SP	27	1.0400	2.0080	0.0810	0.7928	1.6957
	Profitability	27	13.34%	0.2576	1.04%	10.17%	21.75%

Source: IBGE (2016)

Finally, looking on the descriptive for SP model descriptive, data seem to show that firms that performed MR, ER, WR and EIR have less SP (mean and median). But this data does agrees with tradicional economist view authors, that argues that internalizing externalities can affect competitive advantage by reducing profit or value(LANKOSKI, 2000; WAGNER, 2009; SCHALTEGGER; SYNNESTVEDT, 2002).

Table 19 - ROA versus enviromental related innovation

(to be continued)

MR	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/Non relevant	1521	1.3375246	1.5144701	0.4627582	1.1740568	2.1249057
High/Medium	861	1.2651755	1.4231791	0.4212239	1.1244736	2.0125133

ER	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/Non relevant	1570	1.3462806	1.5087763	0.4706427	1.1541254	2.1457532
High/Medium	812	1.2438798	1.4279941	0.398993	1.1580448	1.9881298

WR	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/Non relevant	1739	1.3255231	1.5082734	0.4573205	1.1554133	2.0921777
High/Medium	643	1.2731046	1.4098072	0.4212239	1.1471123	2.0330508

EIR	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
Low/Non relevant	1265	1.3472515	1.5220999	0.4652516	1.1394057	2.1708298
High/Medium	1117	1.2707412	1.4353339	0.4273295	1.1799186	2.0244703

CNAE	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
10	365	1.2971078	1.3376705	0.5159842	1.1192054	2.0303401
11	43	1.7878915	2.0025392	0.6907736	1.6326567	2.9818033
12	2	5.0859997	0.8895112	4.4570203	5.0859997	5.7149792
13	109	1.0800048	1.4770714	0.2333103	0.9603086	1.7819153

(conclusion)

CNAE	N	Mean	Std Dev	Lower Quartile	Median	Upper Quartile
14	94	1.3046576	1.1061654	0.6171538	1.0977036	2.0264482
15	76	1.0916483	0.9179861	0.5606353	0.9254689	1.4341549
16	34	1.1059306	1.3258502	0.4466451	1.1333384	1.6848201
17	70	1.6881769	1.6458472	0.570081	1.5718428	3.2101299
18	29	0.8385776	1.3591995	0.3496651	0.7635417	1.0353501
20	184	1.4187729	1.3624154	0.5410688	1.4387855	2.2050463
21	61	1.0554844	1.1167291	0.6335459	1.3478095	1.7291549
22	149	1.4336376	1.6168496	0.443525	1.4335547	2.2676585
23	115	1.5127676	1.4833675	0.5158155	1.2196038	2.1787706
24	68	1.5127983	1.8435076	0.2793629	1.4391179	2.381153
25	165	1.1905893	1.4649175	0.3523079	1.0653321	1.9680707
26	92	1.2710288	1.5287118	0.3142803	1.0471559	1.8835214
27	114	1.0999937	1.6032867	0.2799766	0.9712745	1.9599614
28	263	1.4012834	1.4783968	0.4585361	1.2037679	2.2086966
29	112	1.165165	2.1261844	-0.251050	1.0548926	2.5804634
30	29	1.0272891	1.6717229	0.2018301	0.7912416	1.8962523
31	107	1.5757821	1.4039078	0.7174234	1.6953886	2.3785927
32	74	1.0155983	0.9270175	0.4738071	0.9102381	1.5403404
33	27	1.2043733	1.1030272	0.5147487	1.0338457	2.1249057

Source: Self elaboration (2017)

Based on this first descriptive analysis, results are in general congruent with what the scarce literature review states.

4.2 Regression analysis

After the descriptive statistics analysis, the second step in the process was to perform the regression analysis to determine the relationship between the firms' GI with SSG, SP and SFP (balance from SP and SSG) and to test the research hypothesis. For this purpose this study uses multivariable linear regression, which is well known as a highly general and very flexible system for analyzing data; used whenever a dependent quantitative variable is to be studied as a function of, or in relationship to, any set of multiple factors of interest (the independent variables) (COHEN et al., 1983).

A Normality test and an analysis of the VIF (variance inflation factor) was performed in order to conduct the analysis. Normality test showed no anomaly in the distribution (annex 3)The VIF analysis did not indicate a problem with the multicollinearity. VIF and other data result can be seen on Annex 5.

4.2.1 Regression analysis part A - SSG

a) Hypotesys 1: GI have positive relation with superior sales Growth;
   – Hypotesys 1a – Innovation related to reduction of material have positive relation with superior sales growth;
   – Hypotesys 1b – Innovation related to reduction of energy material have positive relation with superior sales growth;
   – Hypotesys 1c – Innovation related to Water reduction have positive relation with superior sales growth;
   – Hypotesys 1d – Innovation related to Enviromental impact have a positive relation with superior sales growth.

N= 2596

Y1=0.9782535
+ 0.0326981WR+0.011603EIR
+ 0.0059446Env. Manag Syst +0.0874146kmedian3resear1 +0.0839486kmedian3resear2
+0.0635999kmedian3expen1 +0.1041978kmedian3expen2 + 0.0196820National
+0.0587093cnae12 +0.0156698cnae24 +0.0007065New revenue 1+ 0.0000267New revenue2+0.0003143New revenue 3+ 0.0005263New export 1 +0.0005397New export 2

-0.0236539MR -0.0161197ER
-0.002349Forange -0.038387cnae10 -0.0399349cnae11 -0.1359473cnae13
-0.0241696cnae14 -0.0839754cnae15 -0.0627285cnae16 -0.0691732cnae17
-0.1281001cnae18 -0.0226747cnae20 -0.0768177cnae21 -0.0722262cnae22
-0.0290432cnae23 -0.0557891cnae 25 -0.0078824cnae26 -0.0482103cnae27
-0.0282004cnae28 -0.0935684cnae29 -0.0264194cnae 30 -0.058392cnae 31
-0.0838787cnae 32 -0.0003874New export 3

Table 20 – Analysis of Variance – Superior Sales Growth

Source	DF	Sum of Squares	Mean Square	F Value	p-value
Model	39	7.0866807	0.1817098	1.69	0.0049
Error	2556	274.8243282	0.1075213		
Corrected Total	2595	281.9110089			

Source	DF	Type III SS	Mean Square	F Value	p-value
MR	1	0.22270514	0.22270514	2.07	0.1502
ER	1	0.08499472	0.08499472	0.79	0.374
WR	1	0.29384258	0.29384258	2.73	0.0984
EIR	1	0.06082701	0.06082701	0.57	0.452
Env. Manag Syst	1	0.02069387	0.02069387	0.19	0.6609
kmedian3resear	2	0.06732424	0.03366212	0.31	0.7312
kmedian3expen	2	2.27343569	1.13671784	10.57	<,0001
Control Cap	2	0.18085823	0.09042912	0.84	0.4314
cnae42	22	2.80353702	0.1274335	1.19	0.2498
New revenue 1	1	0.67570537	0.67570537	6.28	0.0122
New revenue 2	1	0.00034823	0.00034823	0	0.9546
New revenue 3	1	0.01061371	0.01061371	0.1	0.7534
New export 1	1	0.14335486	0.14335486	1.33	0.2483
New export 2	1	0.0835417	0.0835417	0.78	0.3781
New export 3	1	0.00580568	0.00580568	0.05	0.8163

Source: Self elaboration (2017)

The coefficient of determination of this regression was R2 = 2.51%, variance analisys (Anova) with $p<0.05$, which suggests there at least one variable with statistical significance with SSG (Y1), and the variable dependent is not being thoroughly explained in the regression.

The following 2 variable that have statistical significant at the 0.05 level: *R&D expenditure* (Cluster), and the *New product sales already existent on the domestic market*. The *Hypotesis1* have been rejected, since all 4 enviromental are not statisticaly significant. Indirectly this also means in rejection of *H1a, H1b, H1c and H1d.*

One probable explanation to this is that although the environmental outputs are classified by firms as important, then most reductions are not significant enough inside a firm to impact the business performance. Since this study uses qualitative answers (by level of importance) then these are subjects to the repliers individual perspective.

4.2.2 Regression analysis part B - SP

b) Hypotesys 2: GI have a positive relation with superior profitability

– Hypotesys 2a – Innovation related to reduction of material have positive relation with superior with superior profitability.

– Hypotesys 2b – Innovation related to reduction of energy material have positive relation with superior with superior profitability.

– Hypotesys 2c – Innovation related to Water reduction have positive relation with superior with superior profitability.

– Hypotesys 2d – Innovation related to Enviromental impact have a positive relation with superior with superior profitability.

N= 2426

Y2=-0.2887855
+0.0140783MR+0.1265508WR
+1.0964756kmedian3resear1 + 1.01194kmedian3resear2 + 0.3391728kmedian3expen1
+ 0.55651National + 0.11103Forange + 0.247985cnae10 +0.6556307cnae11
+7.3846582cnae12 + 0.2020222cnae14 + 1.2388376cnae17 + 0.6091496cnae20
+ 0.1247990cnae21 + 0.6507620cnae23 + 0.2407519cnae24 + 0.126950cnae26
+0.2745483cnae28 + 0.5973925cnae31 + 0.0162930New revenue 3
+0.0023517New export 1 + 0.0034569New export 2 +0.0154027New export 3

-0.1770133EIR -0.15165ER
-0.0679403Env. Manag Syst -0.03305kmedian3expen2
-0.5299700cnae13- 0.0828688cnae15 -0.6491703cnae16
-0.4798820cnae18 -0.0299388cnae22 -0.1123939cnae25
-0.4898113cnae29 -0.2172213cnae30 -0.3060543cnae27
-0.2232713cnae32 -0.0007985New revenue 1-0.0021952New revenue 2

Table 21 – Analysis of Variance – Superior profitability

Source	DF	Sum of Squares	Mean Square	F Value	p-value
Model	39	635.51508	16.29526	1.72	0.0039
Error	2386	22643.38548	9.4901		
Corrected Total	2425	23278.90056			

Source	DF	Type III SS	Mean Square	F Value	p-value
MR	1	0.0729785	0.0729785	0.01	0.9301
ER	1	6.9925194	6.9925194	0.74	0.3908
WR	1	4.1032348	4.1032348	0.43	0.5109
EIR	1	13.1509927	13.1509927	1.39	0.2392
Env. Manag Syst	1	2.5263151	2.5263151	0.27	0.6059
kmedian3resear	2	10.4731612	5.2365806	0.55	0.576
kmedian3expen	2	32.8026931	16.4013466	1.73	0.1778
Control Cap	2	82.5669247	41.2834624	4.35	0.013
cnae42	22	429.9456399	19.5429836	2.06	0.0026
New revenue 1	1	0.8013957	0.8013957	0.08	0.7714
New revenue 2	1	2.256961	2.256961	0.24	0.6258
New revenue 3	1	21.0636084	21.0636084	2.22	0.1364
New export 1	1	2.7059194	2.7059194	0.29	0.5934
New export 2	1	3.1715979	3.1715979	0.33	0.5633
New export 3	1	8.430268	8.430268	0.89	0.346

Source: Self elaboration (2017)

The coefficient of determination of this regression was R2 = 2.5% $p<0.05$, variance analisys (Anova) with $p<0.05$, which suggests there at least one variable with statistical significance with SP (Y2), and the variable dependent is not being thoroughly explained in the regression.

The following 2 variable have statistical significant at the $p<0.05$ level: *Industry code* (CNAE) and *Capital Control origin*. The *Hypotesis2* have been rejected, since all 4 enviromental output are not statisticaly significant. Indirectly this also means in rejection of *H2a, H2b, H2c and H2d.*

Data shown in the annex 4, is based on the variance analysis (Anova), that tests the hypothesis stating that two means are different, in term of ROA. Data shows, based on comparison that Tobacco product manufacturing (CNAE12) possesses the highest ROA means, followed by wood products manufacturing (CNAE16) Automotive manufacturing (CNAE29) printing and recording product manufacturing (CNAE18). The lowest (*difference*) mean is from

the following industries: non-mineral product manufacturing(CNAE23) from chemical product manufacturing (CNAE20) and furniture manufacturing (CNAE31). Simultaneously, data shows that firms with a national controlled capital should outperform firms with a foreign controlled capital when it comes to profitability.

4.2.3 Regression analysis part C - SFP

c) Hypotesys 3: Green Innovation have a positive relation with superior financial performance.

– Hypotesys 3a – Innovation related to reduction of material have positive relation with superior with superior financial performance.

– Hypotesys 3b – Innovation related to reduction of energy material have positive relation with superior with superior financial performance.

– Hypotesys 3c – Innovation related to Water reduction have positive relation with superior with superior financial performance.

– Hypotesys3d – Innovation related to Enviromental impact have a positive relation with superior with superior financial performance.

N=2382

Y3 =0.6429284
+ 0.0032654MR+0.0639278WR
+0.0126583Env. Manag Syst + 0.3806373kmedian3resear1+0.37572973kmedian3resear2
+ 0.1376979kmedian3expen1 + 0.0972902kmedian3expen2 +0.2937516National
+ 0.0850426Forange + 0.0368521cnae10 +0.510750cna 11 + 4.0339111cnae12
+0.0141675cnae14 + 0.4447843cnae17+0.2501429cnae20
+ 0.1969741cnae22 + 0.2809538cnae23 +0.2670663cnae24 + 0.0386715cnae26
0.1647703cnae28 + 0.2857035cnae31 + 0.0004607New revenue 1
0.0116676New revenue 3 +0.0056674New export 3

-0.1158824ER -0.0795209EIR

-0.1830299cnae13-0.1526994cnae15 -0.1962934cnae16
-0.4244054cnae18-0.1700525cnae21-0.0574357cnae25
-0.1273400cnae27-0.0014805cnae29 -0.1445481cnae30
-0.2508332cnae32-0.0025019New revenue 2-0.0003199New export 1
-0.000389New export 2

Table 22 – Analysis of Variance – Superior financial performance

Source	DF	Sum of Squares	Mean Square	F Value	p-value
Model	39	169.584152	4.348312	2.01	0.0002
Error	2342	5061.473179	2.161176		
Corrected Total	2381	5231.057332			

Source	DF	Type III SS	Mean	F Value	p-value
MR	1	0.0038448	0.0038448	0	0.9664
ER	1	4.0051656	4.0051656	1.85	0.1735
WR	1	1.0269509	1.0269509	0.48	0.4907
EIR	1	2.6017673	2.6017673	1.2	0.2727
Env. Manag Syst	1	0.0862397	0.0862397	0.04	0.8417
kmedian3pesq	2	1.1592904	0.5796452	0.27	0.7648
kmedian3disp	2	5.8497473	2.9248737	1.35	0.2586
Control Cap	2	19.2093645	9.6046823	4.44	0.0118
cnae42	22	112.6399885	5.1199995	2.37	0.0003
New revenue 1	1	0.2604942	0.2604942	0.12	0.7285
New revenue 2	1	2.9028492	2.9028492	1.34	0.2466
New revenue 3	1	12.0680762	12.0680762	5.58	0.0182
New export 1	1	0.0495355	0.0495355	0.02	0.8797
New export 2	1	0.04009	0.04009	0.02	0.8917
New export 3	1	1.1639016	1.1639016	0.54	0.4631

Source: Self elaboration (2017)

The coefficient of determination of this regression was R2 = 3.2% $p<0.05$, variance analisys (Anova) with $p<0.05$, which suggests there at least one variable with statistical significance with SP (Y2), and the variable dependent is not being thoroughly explained in the regression.

The following variables have statistical significant at the $p<0.05$ level: *Industry code* (CNAE), *Capital Control origin*, *New revenue 3* (ratio of New product for the firm and global market). The *Hypotesis3* have been rejected, since all 4 enviromental output are not statisticaly significant. Indirectly this also means in rejection of *H3a, H3b, H3c and H3d.*

The variable that presented significant level for this regression model, are same as the Profitability regression, exempt for *New revenue 3*. This last variable coefficient and level of significant could be interpreted as a innovated product with significant impact on firm, allowing to choice between profit or growth.

The below table summarize the results of the regression analysis:

Table 23 – General Study result

H1 – GI have positive correlation with superior sales Growth	Rejected
H1a – Innovation related to reduction of material have positive correlation with superior sales growth.	Hypothesis rejected β= -0.0236538986 p-value=0.1502
H1b – Innovation related to reduction of energy material have positive correlation with superior sales growth.	Rejected β= -0.0161196453 p-value=0.374
H1c – Innovation related to Water reduction have positive correlation with superior sales growth.	Rejected β= 0.0326980624 p-value=0.0984 Accepted for foreign controlled firms (annex2)
H1d – Innovation related to Environmental impact have a positive correlation with superior sales growth.	Rejected β= 0.011602511 p-value=0.452
H2– GI have a positive correlation with superior profitability	Rejected
H2a – Innovation related to reduction of material have positive correlation with superior profitability.	Rejected β= 0.014078311 p-value=0.9301
H2b – Innovation related to reduction of energy material have positive correlation with superior profitability	Rejected β= -0.1516471 p-value=0.3908
H2c – Innovation related to Water reduction have positive correlation with superior profitability	Rejected β= 0.126550812 p-value=0.5109
H2d – Innovation related to Environmental impact have a positive correlation with superior profitability	Rejected β= -0.177013267 p-value=0.2392
H3 – GI have a positive correlation with superior financial performance.	Rejected
H3a – Innovation related to reduction of material have positive correlation with superior financial performance.	Rejected β= 0.003265422 p-value=0.9664
H3b – Innovation related to reduction of energy material have positive correlation with superior financial performance.	Rejected β= -0.115882431 p-value=0.1735
H3c – Innovation related to Water reduction have positive correlation with superior financial performance.	Rejected β= 0.063927753 p-value=0.4907
H3d – Innovation related to Environmental impact have a positive correlation with superior financial performance.	Rejected β= -0.079520847 p-value=0.2727

Source: Self elaboration (2017)

In summary, all hypotheses have been rejected. H2c could be accepted if considering along only foreign controlled companies (Annex2). At first sight, the general result seems to contradict the selected literature, but when data are analyzed beyond the level of

significance some interesting interpretations can be done. This will be discussed in the final part of this study.

5 CONCLUSIONS

This study sought to respond to the following research questions:

By answering the main question: “Do Brazilian manufacturing firms that choose a green line of innovation perform financially different – compared to firms operating with conventional innovative strategies?” this study expects directly to contribute to the existing knowledge of how environmental innovations are associated with financial performance. Results certainly may hold true for the sample itself, and although they cannot be considered to reflect the reality among all manufacturing firms 100%, they brought interesting insights in terms of discussing several conclusions and by keeping the findings into account for further studies.

In order to reply to the first question: Choosing a green line of innovation has not been seen as related to a Superior Sales Growth, Superior Profitability and Superior Financial Performance in the Brazilian manufacturing industry. Although this answer might seem to contradict earlier studies (PORTER,1991; HART, 1995; PORTER; VAN DER LINDE, 1995; SCHMIDHEINY, 1992), this is the undeniable reality for current Brazilian manufacturing firms, and it brings several contributions to an academic discussion.

Considering the lack of significance regarding all GI outputs, one explanation is that most Brazilian manufacturing firms do not possess an effective environmental strategy and are thus unable to create a green competitive advantage. This is meant in the sense that the managers do not have sufficient accumulated knowledge and ability to create value and/or transform this to the financial performance (Tidd et al., 2005). Evidence of this statement can be seen more clearly in ANNEX 2, where this study has used same analysis on firms with a foreign control capital, which should possess more environmental knowledge and experience. In these results, we can see that the innovation related to WR positively correlated with SSG on level of significance $p<0,05$. With such a result, there is a statistical evidence that GI can be positively related to SSG, SP and SFP in a different business scenario.

A second explanation for the hypothesis rejection, is due to a need for a longer period of analysis, since Wagner and Shaltegger (2001) state that many studies focusing on environmental performance have found a negative relation to the financial performance on a short-term period (1-5 years), but on long terms most are positive. Depending on the type of GI, this time lag should be different also, since different types of GI have different upfront cost,

originated from the effort to internalize externality. ANNEX 2 also shows the support this argument, using a three year time laps innovation related to WR has a positive relation to a SFP and innovation related to ER has a negative relation to a SFP.

A third explanation could be that a green competitive advantage is only happening in a few Brazilian industries, such as the electric and electronics industry (Arenhardt et al.,2016), and not in all industries. According to Reinhardt (1998) and Orsato (2002), a green competitive advantage depends on the maker structure, the firm's role in it and the capability of the firm. Add to the fact that not all market consumers are environmentally driven and are therefore not always willing to pay a higher price for green products (MICHAUD; LLERENA, 2011).

To broaden the research, this study also poses a secondary question: "what type of green innovation impact (material/energy/water/pollution) will reflect on the financial performance of a firm?" the purpose of this secondary question was to find an evidence of impact on the financial performance of companies using different types of green knowledge/GI. This would show an evidence of maturity for each type of environmental output/field.

The reply to the secondary question: None of the green innovation efforts reflect on the financial performance of a firm. However, some interpretation is possible when looking beyond the significance level, as has been done previously in earlier literature (such as Cohen et al., 1995).

Data shows that innovation related to MR has shown a positive coefficient/relation (annex 4) to SP and SPF, and a negative relation to SSG but all of them on a not significant level. The negative result does not contradict the win-win hypothesis stated by environmental strategy literature, but can be understood in the sense that firms choosing to focus on MR tend to choose a SP rather than SSG.

For innovation related to ER, the result shows a negative coefficient/relation (annex 4) but it is not on a significant level ($p<0.05$). This result opens up for a new way to discuss this type of environmental innovation, as one possible explanation to this is the need for a longer time lag (WAGNER; SHALTEGGER, 2001), due to large upfront costs in order to present a positive relation. This result seems to be aligned with the traditional view of authors, arguing that the sustainability development brings on unavoidable costs.

For innovation related to WR, the result has shown a positive relation to SP, SSG and SFP, but not on a significant level (the significant level can be seen in annex 2). This could be seen as strong evidence for Brazilian green competitive advantage.

For innovation concerning the EIR this has been related positively to SSG but negatively to SP and SFP as it is not on a significant level. The explanation is similar to MR. One possible explanation is that firms choosing this type of innovation tend to gain the preference of their clients, but if the firm chooses to increase the profitability this value can be lost/destroyed. Michaud and Llerena (2011) mentions an example of this where there was found no evidence that consumers were willing to pay a premium price for green products.

If going beyond the main scope of this study, results show two variables related to a SP and SFP: Firstly, the Industry code is showing a significant level of SP and SFP, and this is furthermore supported by Porters (1989) statement that profitability and/or competitive advantage are different for each industry; Secondly, the Controlled capital origin (National/Foreign/Nat. and For.)from the firms is showing that the national controlled capital has a higher positive relation to a SP and SFP than firms with a foreign controlled capital. A possible explanation to this is that the foreign company tends to search for a sustainable competitive advantage, investing in more strategical resource to create a future value.

Finally, Prahalad (2009) stated that sustainability is the next driver to innovation in order to boost a competitive advantage, and that it is mandatory in a future economy. This sentence is already a reality for some industries and/or countries (evidence on Annex 2 and selected literature), but for the most part of the Brazilian manufacturing industry it is still considered a “next” driver to innovation. Most Brazilian companies are investing in environmental strategies, accumulating environmental knowledge and resources. These firms are aiming for a future competitive advantage and to produce a first entry advantage in green markets.

5.1 Academic and managerial contribution

In 2014, according to the United Nations in overall, investments to “climate compatible and “sustainable development” scenarios are amounting to several trillions. On the other hand, in the same year, there was spent around 1, 6 trillion on innovation, by including all public, private and non-profit organizations worldwide (Pricewaterhouse cooper, 2014). Companies yearly invest in technological innovations aiming to achieve competitiveness on the market, and this financial resource if converted towards a sustainable technology might be the

real answer in order to achieve a real sustainable development. The numbers and figures presented along with this study serve as a parameter to reinforce GI in Brazil as a relevant field of study for universities and for researchers in the field of sustainability, green strategy/innovation.

The main academic and managerial contribution is the data validity. Brazil is a developing country and is placed in a region that the United nations considers in the most need for a sustainable technology, due to the population growth rate and social changes. Therefore, it is crucial to focus on this region in order to reach a global sustainable development.

Simultaneously, this study brings forward 6 academic contribution:

a) this study uses the SFP as the study object, which has been based on the competitive advantage theory. This brings forward a peculiar study object since this is not simply a competitive advantage nor a financial performance but a blend of both. According to Brito and Brito(2012) this should be the more appropriate way to study empirically the competitive advantage. Hopefully this can contribute to an empirical proof of a green competitive advantage;
b) despite the negative answers from both study question, this study brings evidence of Brazilian green competitive advantage (WR positive correlation to SFP, evidenced in annex 2).
c) the quantitative data regarding the financial performance representing partially the competitive advantage, shows a less disputable data than the qualitative answers regarding the competitive advantage;
d) as result shows innovation related to WR have positive correlation with SSG (annex 2) this have not been seen much on the fundamental environmental studies(PORTER,1991; HART, 1995; PORTER; VAN DER LINDE, 1995; SCHMIDHEINY, 1992). Adding to the fact that previoust empirical studies neither highline the importance of this type of GI, this study point out the importance of WR technology for Brazilian Green Competitive Advantage;
e) for the innovation literature, this study contributes by confirming the positive relation between R&D Expenditures and SSG, as seen similarly on Zamith, Brito e Morganti (2007);

f) result show that environmental innovation of Brazilian manufacturing industry still is not efficient, which highlines the importance of academic knowledge to push corporate's GI efficiency.

Through the literature review this study also hopes to highlight the complex role of knowledge, organizational capability and culture by looking at GI in emerging markets.

From a practical perspective, this study seek to help companies become more conscious of their technology choices by presenting a clearer possible scenario for their organizations. In the past, firms thought the investment in the activities of environmental protection was harmful to businesses and avoid investing in environmental investment. This argument is gradually unjustified after many evidence seen on literature review. Additionally, the result on this study, both positive related and negative related (see also on Annex 2), push the environmental strategy discussion to a more complex understanding, raising the demand from business executives and the government for a more advanced environmental knowledge in order to enable future effective public and private projects involving GI. Finally, by confirming positive correlation of WR related innovation (evidence on annex 2), could justify a large public and private investment. Since this seems indicate a maturity of this type of GI, suggesting a great value creation opportunity.

5.2 Limitation and future studies suggestion

To conclude this study has to acknowledge several limitations. Firstly from the used method: secondary sourced data can bring along bias. Also by using qualitative data (Yes/No and/or four-point scale) regarding environmental outputs does not necessarily measure real significant changes. An improvement to this could be possible by using quantitative data such as emission/output averted.

Secondly, this study approach by linking the environmental innovation with the financial performance, many indirect effects have been ignored such as production costs, reduction, raw input cost/reductions, price rise etc. Using the full business performance definition that includes the operational and financial performance could contribute further to environmental literature. One possible approach would be to use mix method, by first exploring

a Brazilian case study validating the statement from previous literature, to later test on quantitative empirical study.

Third, from this study scope, base on whole manufacturing industry, which creates a limitation of the study analysis. A future empirical study could focus on a single (Arenhardt et al.,2016; CHEN et al., 2006) or multiple industry with a more matured environmental strategy capability (WAGNER, 2009). Justified by Reinhardt (1998) and Orsatos (2002) statement saying that while it does pay off to invest in an environmental strategy, this depends on the market structure, a firm's position and its capabilities. Some criteria could be used to select firms or industries such as: ISO certifications, sustainability reports and publicly traded company condition. This last condition would help to ensure the financial data validity since the data found in PIA (2011 and 2014) lack confirmation and does not have a penalty for incorrect data. This can cause a distortion in the analysis. By applying this last condition, future study can be more effecting on showing evidence of Brazilian green competitiveness, helping the sustainable development discussion to gain further support.

Last but not least, from this study's result: industry classification impact on SP and SFP. Environmental regulation could be one possible explanation for difference between industry, justifying a future study to fill this study gap. Since result seem to show the importance of green strategical efficiency, a empirical study focus on green managerial capability could help Brazilian firms to boost GI efficiency and impact. Finally WR related innovation could be a relevant academic's study object for future study since statistical data show a higher correlation (with level of significance) than traditional innovation output: R&D expenditure (cluster), seen on annex 2.

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APPENDIX

Annex 1- Metodological Comparison with selected GI studies

Authors	COMPETITIVE ADVANTAGE VARIABLES																				Method
	Financial performance							Operational performance													
	Number of item	Competitive advantage	ROA	profit(long and short)	Sales	growth/Market share	Low cost/Cost saving	First mover/newmarket	Quality	productivity	managerial capability	corporate image	Imitability of product/idea	replacement of product	R&D capability	improved insurance condition	better credit acess	owner/management/worker satisfaction	recuitment and staff retention	
RUSSO and FOUTS (1997)	1		X																		Quantitative
CHEN et. Al.(2006)	11			X		X	X	X	X		X	X	X	X	X						7 liker scale (desagree to agree)
WAGNER (2009)	15	X		X	X	X	X	X		X		X				X	X	X	X		5 point scale (no to very much)
This study	2			X		X															Quantitative

Authors	ENVIROMENTAL OUTPUT																			Method
	Number of item	Productivity/material use	water use	energy use	solid waste/water waste	soil contamination	emission to air	noise	smell	landscape damage	management system	risk of severe accident	non renewable resource	toxic input	enviromental compliance	enviromental lawsuit/controversy	waste efford	Support enviromental NGO	efford beond law	
RUSSO and FOUTS (1997)	7	X													X	X	X	X	X	5 point scale no to very much
CHEN et. Al.(2006)	7	x	x	x		x	x				X		x							7 liker scale from desagree to agree
WAGNER (2009)	12		X	X	X	X	X	X	X	X		X	X	X						5 point scale no to very much
This study	4	X	X	X			X													4 point scale no to very much

Annex 2 –multivariable linear regression – 2011-2014 (only firm with foreign controlled capital)

Linear Multivariable regression with 2011-2014 data (only firms with foreign capital control)

CRESC rel
n=440

Source	DF	Sum of Squares	Mean Square	F Value	p-value
Model	37	4.78401164	0.12929761	1.14	0.2726
Error	402	45.7069396	0.11369885		
Corrected Total	439	50.49095124			

R-Square	Coeff Var	Root MSE	cresc_rel Mean
0.09475	32.44267	0.337193	1.039349

Source	DF	Type III SS	Mean Square	F Value	p-value
MR	1	0.02517338	0.02517338	0.22	0.6382
ER	1	0.53218387	0.53218387	4.68	0.0311
WR	1	0.58043255	0.58043255	5.1	0.0244
EIR	1	0.00382155	0.00382155	0.03	0.8546
Env. Manag	1	0.194477	0.194477	1.71	0.1917
kmedian3pesq	2	0.40636052	0.20318026	1.79	0.1688
kmedian3disp	2	0.3808638	0.1904319	1.67	0.1886
cnae42	22	2.90724854	0.13214766	1.16	0.2783
New revenue 1	1	0.03895849	0.03895849	0.34	0.5586
New revenue 2	1	0.00070466	0.00070466	0.01	0.9373
New revenue 3	1	0.13118785	0.13118785	1.15	0.2834
New export 1	1	0.14099592	0.14099592	1.24	0.2661
New export 2	1	0.00358563	0.00358563	0.03	0.8591
New export 3	1	0.11625409	0.11625409	1.02	0.3125

Parameter	Estimate	Standard Error	t Value	p-value	95% Confidence Limits		VIF
Intercept	0.848307	0.2485	3.41	0.0007	0.35964	1.33697	0.543442
MR	-0.020904	0.0444	-0.47	0.6382	-0.10824	0.06643	1.747905
ER	-0.111134	0.0513	-2.16	0.0311	-0.21212	-0.01015	2.404680
WR	0.126281	0.0558	2.26	0.0244	0.01641	0.23616	2.538599
EIR	0.007836	0.0427	0.18	0.8546	-0.07619	0.09186	1.766648
Env. Manag	0.044836	0.0342	1.31	0.1917	-0.02256	0.11223	1.118607
No Env.	0.000000	,	,	,	,	,	0
kmedian3pesq	0.100317	0.1525	0.66	0.5112	-0.19958	0.40022	1.823179
kmedian3pesq	0.007953	0.1501	0.05	0.9578	-0.28722	0.30313	1.842963
kmedian3pesq	0.000000	,	,	,	,	,	0
kmedian3disp	0.072938	0.0590	1.24	0.2175	-0.04316	0.18903	1.027676
kmedian3disp	0.148517	0.1034	1.44	0.152	-0.05490	0.35193	1.023924
kmedian3disp	0.000000	,	,	,	,	,	0
cnae10	0.071374	0.2062	0.35	0.7294	-0.33401	0.47676	1.059998
cnae11	-0.053995	0.2615	-0.21	0.8365	-0.56811	0.46012	1.019942
cnae12	0.141715	0.2769	0.51	0.6091	-0.40267	0.68610	1.015987
cnae13	0.121448	0.2295	0.53	0.597	-0.32974	0.57264	1.032497
cnae14	0.335405	0.4037	0.83	0.4066	-0.45825	1.12906	1.008165
cnae15	0.417112	0.3104	1.34	0.1798	-0.19320	1.02742	1.011965
cnae16	0.225932	0.3939	0.57	0.5667	-0.54861	1.00048	1.007049
cnae17	0.134941	0.2163	0.62	0.5332	-0.29036	0.56025	1.039844
cnae18	-0.015625	0.3142	-0.05	0.9604	-0.63343	0.60218	1.012526
cnae20	0.183905	0.2023	0.91	0.364	-0.21391	0.58172	1.066597
cnae21	0.057698	0.2095	0.28	0.7832	-0.35434	0.46974	1.049620
cnae22	0.249012	0.2073	1.2	0.2304	-0.15856	0.65659	1.053512
cnae23	0.219099	0.2136	1.03	0.3058	-0.20100	0.63920	1.043691
cnae24	0.211261	0.2178	0.97	0.3327	-0.21700	0.63953	1.041749
cnae25	0.117005	0.2089	0.56	0.5759	-0.29385	0.52786	1.050441
cnae26	0.250907	0.2085	1.2	0.2297	-0.15916	0.66098	1.049391
cnae27	0.071813	0.2059	0.35	0.7275	-0.33306	0.47668	1.056840
cnae28	0.197563	0.2013	0.98	0.3271	-0.19828	0.59341	1.070462
cnae29	0.061047	0.2020	0.3	0.7627	-0.33624	0.45833	1.069377
cnae30	-0.028864	0.2316	-0.12	0.9009	-0.48418	0.42646	1.030218
cnae31	0.488992	0.3125	1.56	0.1185	-0.12545	1.10343	1.012275
cnae32	0.053139	0.2317	0.23	0.8187	-0.40242	0.50869	1.030242
cnae33	0.000000	,	,	,	,	,	0
New revenue 1	-0.000419	0.0007	-0.59	0.5586	-0.00182	0.00099	1.382115
New revenue 2	-0.000077	0.0009	-0.08	0.9373	-0.00199	0.00184	1.400648
New revenue 3	0.001903	0.0017	1.07	0.2834	-0.00158	0.00539	1.478214
New export 3	0.001172	0.0010	1.11	0.2661	-0.00090	0.00324	1.319502
New export 2	0.000235	0.0013	0.18	0.8591	-0.00237	0.00284	1.384390
New export 3	-0.003261	0.0032	-1.01	0.3125	-0.00960	0.00308	1.514647

The coefficient of determination of this regression was R2 = 9.47% $p<0.05$, variance analisys (Anova) with $p<0.05$, which suggests there at least one variable with statistical significance with SSG (Y1).

The following 4 variable that have significant level $p<0.05$: Innovation related to *WR* and *ER*. The *Hypotesis1* have been rejected, since not all 4 enviromental output have related as significant. H1c have been accepted on significant level. H1a and H1d have been rejected since it posses no level of significance. H1b have been rejected since the coefficient is negative correlated on significant level.

Analisying beyond significance level, two type of GI (WR/EIR) are positively correlated. While innovation related to MR and ER possess negative correlation to SSG. At first sight this result might seem contradicting the previous regression, since innovation related to environmental and MR and ER possess negative coefficient. But if taken account of literature review, that firms in competitive advantage can chose between these two outcomes (profit or growth), then is possible to suppose that many innovation related to MR tend to choose SP instead of SSG. In a deeper perception, the capacity of MR control could indicate a firmer financial control culture increasing the capacity to achieve SP. This also seem to happen to the existence of environmental management system, which tend to transform to SP (seen on next result analisys).

It is interesting to see that at SP regression model, one environmental output(WR) have been positively correlated at a significant level. This could be evidence the important role of GI outweighing other type of strategical resource.

Multivariable Linear regression with 2011-2014 data (only firms with foreign capital control)

ROA rel
n=412

Source	DF	Sum of Squares	Mean Square	F Value	p-value
Model	37	610.77284	16.507374	1.61	0.0155
Error	374	3827.445693	10.233812		
Corrected Total	411	4438.218533			

R-Square	Coeff Var	Root MSE	roa_rel Mean
0.137617	346.7939	3.199033	0.922459

Source	DF	Type III SS	Mean Square	F Value	p-value
MR	1	0.3405089	0.3405089	0.03	0.8554
ER	1	52.5849702	52.5849702	5.14	0.024
WR	1	15.0711983	15.0711983	1.47	0.2257
EIR	1	5.0085811	5.0085811	0.49	0.4846
Env. Manag Syst	1	15.795015	15.795015	1.54	0.2149
kmedian3pesq	2	9.806633	4.9033165	0.48	0.6197
kmedian3disp	2	0.2135306	0.1067653	0.01	0.9896
cnae42	22	456.0405285	20.7291149	2.03	0.0044
New revenue 1	1	16.6410844	16.6410844	1.63	0.203
New revenue 2	1	1.1012413	1.1012413	0.11	0.7431
New revenue 3	1	30.7829291	30.7829291	3.01	0.0837
New export 1	1	55.6294096	55.6294096	5.44	0.0203
New export 2	1	2.6188454	2.6188454	0.26	0.6132
New export 3	1	0.5535122	0.5535122	0.05	0.8162

Parameter	Estimate	Standard Error	t Value	p-value	95% Confidence Limits		VIF
Intercept	0.185737	2.092990	0.09	0.9293	-3.92977	4.30124	0.428052
MR	0.080029	0.438732	0.18	0.8554	-0.78266	0.94272	1.783732
ER	-1.160560	0.511983	-2.27	0.024	-2.16729	-0.15383	2.470114
WR	0.656781	0.541209	1.21	0.2257	-0.40741	1.72098	2.492229
EIR	0.292057	0.417473	0.7	0.4846	-0.52883	1.11294	1.753446
Env. Manag	-0.417518	0.336074	-1.24	0.2149	-1.07835	0.24331	1.117231
No Env.	0.000000	,	,	,	,	,	0
kmedian3pes	0.643356	1.476538	0.44	0.6633	-2.26000	3.54671	1.805080
kmedian3pes	0.182119	1.462812	0.12	0.901	-2.69425	3.05849	1.833582
kmedian3pes	0.000000	,	,	,	,	,	0
kmedian3disp	0.070594	0.589717	0.12	0.9048	-1.08898	1.23017	1.034299
kmedian3disp	-0.067277	0.923978	-0.07	0.942	-1.88412	1.74957	1.030623
kmedian3disp	0.000000	,	,	,	,	,	0
cnae10	0.628247	1.558547	0.4	0.6871	-2.43637	3.69286	1.050042
cnae11	1.297073	2.374104	0.55	0.5852	-3.37119	5.96534	1.011310
cnae12	9.209472	3.551918	2.59	0.0099	2.22524	16.19370	1.004712
cnae13	0.471328	1.818522	0.26	0.7956	-3.10448	4.04714	1.024045
cnae14	1.680097	3.648928	0.46	0.6455	-5.49489	8.85508	1.005943
cnae15	-0.125153	2.710630	-0.05	0.9632	-5.45514	5.20483	1.008145
cnae16	0.450463	3.564882	0.13	0.8995	-6.55926	7.46019	1.004878
cnae17	2.867489	1.679936	1.71	0.0887	-0.43582	6.17079	1.031925

cnae18	2.990313	2.721835	1.1	0.2726	-2.36171	8.34233	1.008334
cnae20	1.472412	1.526601	0.96	0.3354	-1.52939	4.47421	1.055313
cnae21	0.449086	1.615579	0.28	0.7812	-2.72767	3.62584	1.039669
cnae22	-0.228070	1.621108	-0.14	0.8882	-3.41570	2.95956	1.038841
cnae23	1.936910	1.660493	1.17	0.2442	-1.32816	5.20198	1.032834
cnae24	2.001474	1.721472	1.16	0.2457	-1.38350	5.38645	1.031512
cnae25	1.320210	1.604005	0.82	0.411	-1.83379	4.47421	1.038341
cnae26	0.954949	1.602709	0.6	0.5516	-2.19650	4.10640	1.040236
cnae27	-1.230968	1.572302	-0.78	0.4342	-4.32263	1.86069	1.044962
cnae28	0.983218	1.518525	0.65	0.5177	-2.00270	3.96914	1.058763
cnae29	-0.642370	1.551884	-0.41	0.6792	-3.69388	2.40914	1.052328
cnae30	0.811598	1.851888	0.44	0.6615	-2.82982	4.45302	1.022210
cnae31	2.482829	3.546760	0.7	0.4843	-4.49126	9.45692	1.004645
cnae32	0.128307	1.857842	0.07	0.945	-3.52482	3.78143	1.022359
cnae33	0.000000	,	,	,	,	,	0
New revenue	-0.009184	0.007202	-1.28	0.203	-0.02335	0.00498	1.397331
New revenue	-0.003072	0.009363	-0.33	0.7431	-0.02148	0.01534	1.368117
New revenue	0.029177	0.016823	1.73	0.0837	-0.00390	0.06226	1.482607
New export 1	0.024204	0.010381	2.33	0.0203	0.00379	0.04462	1.331921
New export 2	0.006594	0.013035	0.51	0.6132	-0.01904	0.03222	1.334361
New export 3	-0.007669	0.032976	-0.23	0.8162	-0.07251	0.05717	1.557953

The coefficient of determination of this regression was R2 = 13.76% $p<0.05$, variance analisys (Anova) with $p<0.05$, which suggests there at least one variable with statistical significance with SSG (Y2).

The following 3 variable have relation at significant level: Innovation related to ER, Industry code, New product export new to the firm but not for national market. The *Hypotesis2* have been rejected, since not all 4 enviromental output posses level of significance. And also rejection of *H2a, H2b and H2d. H2c have been confirmed.* H2b is rejected since the variable has significant level but negative correlation.

Going beyond level of significance, innovation related to MR, WR and EIR are positively correlated with SP, at same time that innovation related to *ER* are negatively related. While innovation related to ER can seem as opposite to recent GI studies, a possible explanation can be related a need for a longer period analisys, since Wagner and Shaltegger (2001) state that many studies using environmental performance have a negative relation with financial performance on a short term period (1-5 years), but on long term most are positive. Depending of the type of environmental innovation, this time lag should be different also, since different type of GI have different upfront cost, from the effort to internalize externality.

Multivariable Linear regression with 2011-2014 data (only firms with foreign capital control)

PSF
n=400

Source	DF	Sum of Squares	Mean Square	F Value	p-value
Model	37	144.8821674	3.9157343	1.83	0.003
Error	362	775.0526297	2.1410294		
Corrected Total	399	919.9347971			

R-Square	Coeff Var	Root MSE	psf Mean
0.157492	124.9566	1.463226	1.170987

Source	DF	Type III SS	Mean Square	F Value	p-value
MR	1	0.5287265	0.5287265	0.25	0.6195
ER	1	16.0544029	16.0544029	7.5	0.0065
WR	1	1.7017322	1.7017322	0.79	0.3732
EIR	1	2.6279818	2.6279818	1.23	0.2686
Env. Manag Syst	1	1.5045549	1.5045549	0.7	0.4024
kmedian3pesq	2	2.2946885	1.1473443	0.54	0.5856
kmedian3disp	2	1.577021	0.7885105	0.37	0.6922
cnae42	22	111.2719835	5.0578174	2.36	0.0006
New revenue 1	1	0.0249201	0.0249201	0.01	0.9141
New revenue 2	1	0.3248195	0.3248195	0.15	0.6971
New revenue 3	1	6.4280787	6.4280787	3	0.084
New export 1	1	5.2163392	5.2163392	2.44	0.1194
New export 2	1	0.0902955	0.0902955	0.04	0.8374
New export 3	1	0.0531224	0.0531224	0.02	0.8749

Parameter	Estimate	Standard Error	t Value	p-value	95% Confidence Limits		VIF
Intercept	0.666007	0.960884	0.69	0.4887	-1.22361	2.55562	0.4312406
MR	0.102293	0.205845	0.5	0.6195	-0.30251	0.50709	1.8238924
ER	-0.650003	0.237372	-2.74	0.0065	-1.11680	-	2.4672205
WR	0.225088	0.252474	0.89	0.3732	-0.27141	0.72159	2.5359290
EIR	0.216045	0.195005	1.11	0.2686	-0.16744	0.59953	1.7753880
Env. Manag	-0.130883	0.156131	-0.84	0.4024	-0.43792	0.17616	1.1207703

No Env.	0.000000	,	,	,	,	,	0
kmedian3pes	0.567983	0.677115	0.84	0.4021	-0.76359	1.89956	1.7986755
kmedian3pes	0.396492	0.670704	0.59	0.5548	-0.92247	1.71546	1.8274163
kmedian3pes	0.000000	,	,	,	,	,	0
kmedian3disp	0.135694	0.275414	0.49	0.6225	-0.40592	0.67731	1.0379425
kmedian3disp	0.322144	0.438576	0.73	0.4631	-0.54033	1.18462	1.0310160
kmedian3disp	0.000000	,	,	,	,	,	0
cnae10	0.000434	0.716544	0	0.9995	-1.40868	1.40955	1.0491193
cnae11	-0.042247	1.086458	-0.04	0.969	-2.17881	2.09432	1.0113283
cnae12	4.413944	1.238654	3.56	0.0004	1.97808	6.84980	1.0080984
cnae13	-0.300690	0.832129	-0.36	0.718	-1.93710	1.33572	1.0240493
cnae14	-0.096735	1.676155	-0.06	0.954	-3.39296	3.19949	1.0061372
cnae15	-0.361478	1.240421	-0.29	0.7709	-2.80081	2.07786	1.0081638
cnae16	-0.240432	1.631824	-0.15	0.8829	-3.44948	2.96861	1.0049121
cnae17	1.049100	0.769040	1.36	0.1734	-0.46325	2.56145	1.0319384
cnae18	0.896679	1.245495	0.72	0.472	-1.55263	3.34599	1.0083508
cnae20	0.437819	0.699386	0.63	0.5317	-0.93755	1.81319	1.0549032
cnae21	-0.200822	0.740338	-0.27	0.7863	-1.65672	1.25508	1.0397159
cnae22	-0.077551	0.750328	-0.1	0.9177	-1.55310	1.39800	1.0372370
cnae23	0.623060	0.759897	0.82	0.4128	-0.87131	2.11743	1.0328304
cnae24	0.792445	0.788606	1	0.3156	-0.75838	2.34327	1.0315597
cnae25	0.404306	0.737313	0.55	0.5838	-1.04565	1.85426	1.0375001
cnae26	0.151857	0.734033	0.21	0.8362	-1.29165	1.59536	1.0402547
cnae27	-0.755670	0.724377	-1.04	0.2976	-2.18019	0.66885	1.0430239
cnae28	0.243581	0.696220	0.35	0.7266	-1.12556	1.61272	1.0584408
cnae29	-0.498337	0.715725	-0.7	0.4867	-1.90584	0.90916	1.0511882
cnae30	-0.207897	0.847590	-0.25	0.8064	-1.87472	1.45892	1.0222260
cnae31	0.578852	1.622718	0.36	0.7215	-2.61229	3.76999	1.0046566
cnae32	-0.393690	0.850545	-0.46	0.6437	-2.06632	1.27894	1.0223877
cnae33	0.000000	,	,	,	,	,	0
New revenue	0.000373	0.003453	0.11	0.9141	-0.00642	0.00716	1.4369869
New revenue	-0.001674	0.004299	-0.39	0.6971	-0.01013	0.00678	1.3681559
New revenue	0.013352	0.007706	1.73	0.084	-0.00180	0.02851	1.4851271
New export 3	0.007539	0.004830	1.56	0.1194	-0.00196	0.01704	1.3736645
New export 2	0.001230	0.005988	0.21	0.8374	-0.01055	0.01301	1.3410943
New export 3	-0.002379	0.015103	-0.16	0.8749	-0.03208	0.02732	1.5612495

The coefficient of determination of this regression was R2 = 15.75%p<0.05, variance analisys (Anova) with p<0.05, which suggests there at least one variable with statistical significance with SSG (Y3).

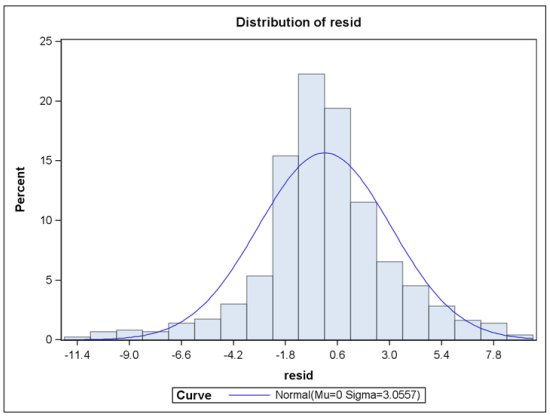
The following variables have significant level p<0.05: *Industry code* (CNAE) and *Innovation related to ER*. The *Hypotesis2* have been rejected, since all 4 enviromental output have not related as significant. Indirectly this also means in rejection of *H3a, H3c and H3d.*

H3b have been rejected since the coefficient show a negative relation to SFP. Looking beyond significant level, within the GI output, all but the ER have a positive relation with SFP.

In the end, innovation related to ER has been seen negative in all outcomes (SP and/or SSG), a possible explanation is that innovation on ER could be related to implementation of renewable energy, such as solar energy that posses a payback time up to 5-7 years, in such cases the CAPEX and Assest increase, lowering his profitability.

ANNEX 3 – Normality test from regressional model

Normality test - Superior profitability regression



Quantiles for Normal Distribution

	Quantile	
Percent	Observed	Estimated
1.0	-9.44881	-7.108688
5.0	-5.08978	-5.026227
10.0	-3.16334	-3.916074
25.0	-1.44365	-2.061058
50.0	-0.12808	-0.000000
75.0	1.50946	2.061058
90.0	3.79796	3.916074
95.0	5.39485	5.026227
99.0	7.77614	7.108688

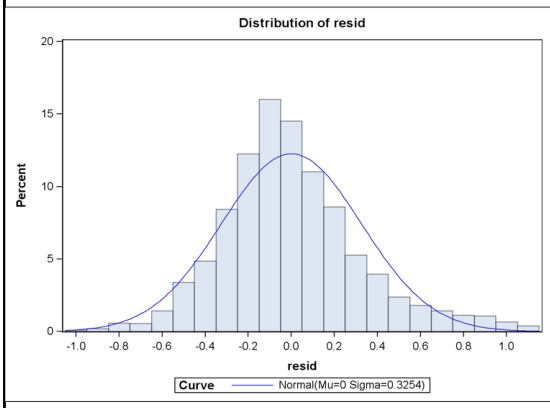
Parameters for Normal Distribution

Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	3.055729

Goodness-of-Fit Tests for Normal Distribution

Test		Statistic		p Value
Kolmogorov-Smirnov	D	0.0788647	Pr > D	<0.010
Cramer-von Mises	W-Sq	4.5732747	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	26.7387728	Pr > A-Sq	<0.005

Normality test - Superior Sales Growth regression



Quantiles for Normal Distribution

Percent	Quantile Observed	Estimated
1.0	-0.73826	-0.757066
5.0	-0.47976	-0.535286
10.0	-0.36836	-0.417057
25.0	-0.20230	-0.219500
50.0	-0.03097	-0.000000
75.0	0.16645	0.219500
90.0	0.41622	0.417057
95.0	0.61704	0.535286
99.0	0.96118	0.757066

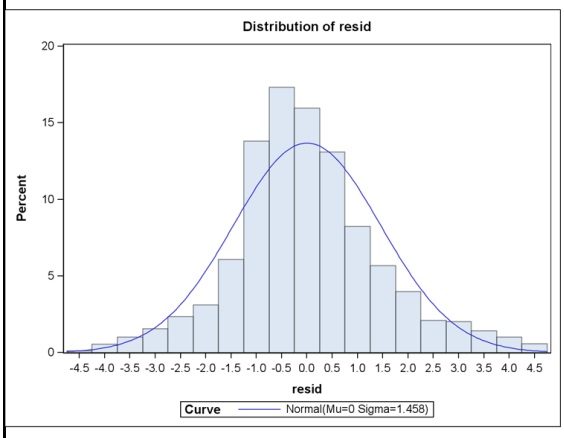
Parameters for Normal Distribution

Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	0.325431

Goodness-of-Fit Tests for Normal Distribution

Test		Statistic		p Value
Kolmogorov-Smirnov	D	0.0683996	Pr > D	<0.010
Cramer-von Mises	W-Sq	3.4320047	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	20.5271627	Pr > A-Sq	<0.005

Normality test -Superior financial performance regression



Quantiles for Normal Distribution

Percent	Quantile Observed	Estimated
1.0	-3.56109	-3.391825
5.0	-2.38334	-2.398203
10.0	-1.61877	-1.868508
25.0	-0.85303	-0.983409
50.0	-0.11581	-0.000000
75.0	0.75136	0.983409
90.0	1.87255	1.868508
95.0	2.75401	2.398203
99.0	3.94148	3.391825

Parameters for Normal Distribution

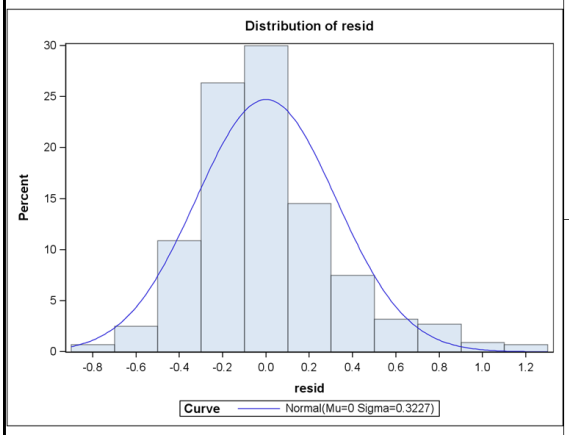
Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	1.458004

Goodness-of-Fit Tests for Normal Distribution

Test		Statistic		p Value
Kolmogorov-Smirnov	D	0.0606488	Pr > D	<0.010
Cramer-von Mises	W-Sq	2.7567513	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	15.953217	Pr > A-Sq	<0.005

0

Normality test – Superior Sales Growth (only foreign capital control)



Quantiles for Normal Distribution

Percent	Quantile Observed	Quantile Estimated
1.0	-0.68121	-0.750643
5.0	-0.43136	-0.530745
10.0	-0.34344	-0.413518
25.0	-0.20625	-0.217638
50.0	-0.04616	-0.000000
75.0	0.13587	0.217638
90.0	0.40685	0.413518
95.0	0.67634	0.530745
99.0	1.01461	0.750643

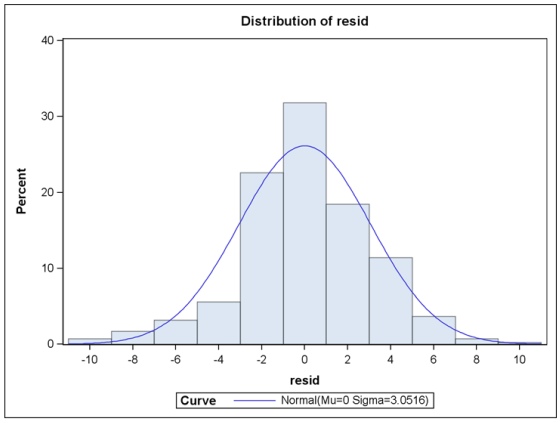
Parameters for Normal Distribution

Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	0.32267

Goodness-of-Fit Tests for Normal Distribution

Test		Statistic		p Value
Kolmogorov-Smirnov	D	0.09180630	Pr > D	<0.010
Cramer-von Mises	W-Sq	1.00550580	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	5.95589186	Pr > A-Sq	<0.005

Normality test – Superior Profitability (only foreign capital control)



Quantiles for Normal Distribution

Percent	Quantile Observed	Quantile Estimated
1.0	-8.367170	-7.099181
5.0	-5.423263	-5.019505
10.0	-3.248435	-3.910837
25.0	-1.665060	-2.058301
50.0	-0.000000	-0.000000
75.0	1.759062	2.058301
90.0	4.027079	3.910837
95.0	4.862905	5.019505
99.0	6.939989	7.099181

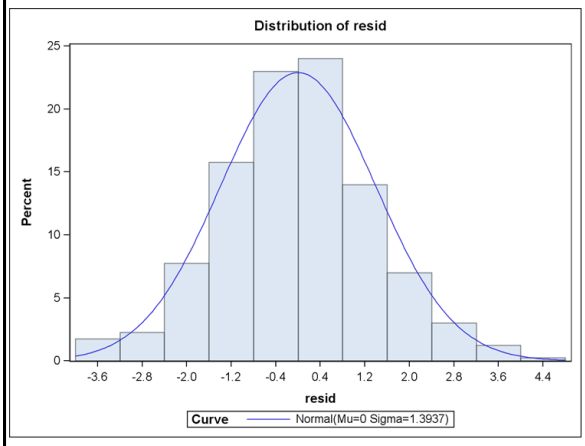
Parameters for Normal Distribution

Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	3.051642

Goodness-of-Fit Tests for Normal Distribution

Test		Statistic		p Value
Kolmogorov-Smirnov	D	0.05562290	Pr > D	<0.010
Cramer-von Mises	W-Sq	0.30001071	Pr > W-Sq	<0.005
Anderson-Darling	A-Sq	1.84900134	Pr > A-Sq	<0.005

Normality test – Superior financial performance (only foreign capital control)



Quantiles for Normal Distribution

Percent	Quantile Observed	Quantile Estimated
1.0	-3.24724	-3.242305
5.0	-2.25611	-2.292484
10.0	-1.69157	-1.786139
25.0	-0.88465	-0.940058
50.0	-0.01498	-0.000000
75.0	0.83462	0.940058
90.0	1.77823	1.786139
95.0	2.32288	2.292484
99.0	3.39743	3.242305

Parameters for Normal Distribution

Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	1.393732

Goodness-of-Fit Tests for Normal Distribution

Test		Statistic		p Value
Kolmogorov-Smirnov	D	0.03557258	Pr > D	>0.150
Cramer-von Mises	W-Sq	0.08432714	Pr > W-Sq	0.189
Anderson-Darling	A-Sq	0.55763582	Pr > A-Sq	0.153

Annex 4 – Industry classification code (CNAE Code) according to IBGE

10	FOOD PRODUCT MANUFACTURING
11	BEVERAGE PRODUCT MANUFACTURING
12	TOBACCO PRODUCT MANUFACTURING
13	TEXTILE PRODUCT MANUFACTURING
14	CLOTH AND ACCESSORIES PRODUCT MANUFACTURIN
15	FOOTWARE/LEATHER RELATED/ TRAVEL EQUIPMENT MANUFACTURING
16	WOOD PRODUCT MANUFACTURING
17	CELLULOSE AND PAPER INDUSTRY MANUFACTURING
18	PRINTING AND RECORDING PRODUCT MANUFACTURING
19	MATERIALS DERIVED FROM CRUDE OIL AND BIOFUELS MANUFACTURING
20	CHEMICAL PRODUCT MANUFACTURING
21	PHARMACEUTICAL AND FARM CHEMICAL PRODUCT MANUFACTURING
22	RUBBER AND PLASTIC PRODUCT MANUFACTURING
23	NON MINERAL PRODUCT MANUFACTURING
24	METALLURGY PRODUCT MANUFACTURING,
25	METAL MADE PRODUCT (NON-MACHINE AND EQUIPEMENT) MANUFACTURING
26	OPTICAL/ELECTRONICAL/ELECTRICAL PRODUCT MANUFACTURING
27	ELECTRICAL MACHINES/DEVICES MANUFACTURING
28	MARCHINES AND EQUIPMENT MANUFACTURING
29	AUTOMOTIVE MANUFACTURING
30	OTHER TRANSPORTATION EQUIPMENT (NON-AUTO) MANUFACTURING
31	FURNATURE MANUFACTURING,
32	OTHER DIVERSED PRODUCT MANUFACTURING,
33	MANTAINACE/REPARATION OF MACHINE AND EQUIPMENT

Annex 5 – Variance analisys

Variance Analisys PART A – SSG

Parameter	Estimate	Standard	t Value	p-	95%		VIF
Intercept	0.978254	0.130064	7.52	<.0001	0.7232	1.2333	0.157332763
Material Reduct	-0.023654	0.016436	-1.44	0.1502	-0.0559	0.0086	1.500858578
Energy Reduct	-0.016120	0.018130	-0.89	0.374	-0.0517	0.0194	1.789024962
Water Reduct	0.032698	0.019779	1.65	0.0984	-0.0061	0.0715	1.856847533
Enviro. Reduct	0.011603	0.015426	0.75	0.452	-0.0186	0.0419	1.431268828
Env. Manag Syst	0.005945	0.013550	0.44	0.6609	-0.0206	0.0325	1.101278412
No Env. Manag	0.000000	-	-	-	-	-	0
kmedian3resear1	0.087415	0.110656	0.79	0.4296	-0.1296	0.3044	2.012295484
kmedian3resear2	0.083949	0.108391	0.77	0.4387	-0.1286	0.2965	2.021295261
kmedian3resear3	0.000000	-	-	-	-	-	0
kmedian3expen1	0.063600	0.019150	3.32	0.0009	0.0260	0.1012	1.00930522
kmedian3expen2	0.104198	0.029678	3.51	0.0005	0.0460	0.1624	1.006522637
kmedian3expen3	0.000000	-	-	-	-	-	0
National	0.019682	0.030747	0.64	0.5222	-0.0406	0.0800	3.886651549
Forange	-0.002349	0.033532	-0.07	0.9441	-0.0681	0.0634	3.821502222
Nat and Fog	0.000000	-	-	-	-	-	0
cnae 10	-0.038387	0.067954	-0.56	0.5722	-0.1716	0.0949	1.061904112
cnae 11	-0.039935	0.081427	-0.49	0.6239	-0.1996	0.1197	1.024054068
cnae 12	0.058709	0.177580	0.33	0.741	-0.2895	0.4069	1.003600922
cnae 13	-0.135947	0.072484	-1.88	0.0608	-0.2781	0.0062	1.039711314
cnae 14	-0.024170	0.073851	-0.33	0.7435	-0.1690	0.1206	1.0359796
cnae 15	-0.083975	0.076246	-1.1	0.2708	-0.2335	0.0655	1.031336086
cnae 16	-0.062728	0.084019	-0.75	0.4554	-0.2275	0.1020	1.021825329
cnae 17	-0.069173	0.075727	-0.91	0.3611	-0.2177	0.0793	1.031919652
cnae 18	-0.128100	0.089781	-1.43	0.1538	-0.3042	0.0480	1.017546905
cnae 20	-0.022675	0.069981	-0.32	0.746	-0.1599	0.1145	1.049025358
cnae 21	-0.076818	0.078132	-0.98	0.3256	-0.2300	0.0764	1.028814625
cnae 22	-0.072226	0.070078	-1.03	0.3028	-0.2096	0.0652	1.048054763
cnae 23	-0.029043	0.072277	-0.4	0.6878	-0.1708	0.1127	1.040319232
cnae 24	0.015670	0.074738	0.21	0.8339	-0.1309	0.1622	1.0338135
cnae 25	-0.055789	0.070289	-0.79	0.4274	-0.1936	0.0820	1.047230258
cnae 26	-0.007882	0.074030	-0.11	0.9152	-0.1530	0.1373	1.035858862
cnae 27	-0.048210	0.072202	-0.67	0.5044	-0.1898	0.0934	1.040086833
cnae 28	-0.028200	0.068794	-0.41	0.6819	-0.1631	0.1067	1.055308375
cnae 29	-0.093568	0.070918	-1.32	0.1872	-0.2326	0.0455	1.045842746
cnae 30	-0.026419	0.090833	-0.29	0.7712	-0.2045	0.1517	1.017282955
cnae 31	-0.058392	0.072713	-0.8	0.422	-0.2010	0.0842	1.039090733
cnae 32	-0.083879	0.076320	-1.1	0.2719	-0.2335	0.0658	1.031072044
cnae 33	0.000000	-	-	-	-	-	0
New revenue 1	0.000706	0.000282	2.51	0.0122	0.0002	0.0013	1.227639877
New revenue 2	0.000027	0.000469	0.06	0.9546	-0.0009	0.0009	1.32109857
New revenue 3	0.000314	0.001000	0.31	0.7534	-0.0016	0.0023	1.274045405
New export 1	0.000526	0.000456	1.15	0.2483	-0.0004	0.0014	1.212469563
New export 2	0.000540	0.000612	0.88	0.3781	-0.0007	0.0017	1.292541557
New export 3	-0.000387	0.001667	-0.23	0.8163	-0.0037	0.0029	1.284061319

Least Squares Means for Effect

Effects	Comparisons	Difference Between Means	95% Confidence Limits	p-value

kmedian3disp	**(1 - 3)**	0.0636	0.026049	0.10115	0.0009
	(2 - 3)	0.104198	0.046002	0.162394	0.0005

Variance Analisys PART B – SP

Parameter	Estimate	Standard Error	t Value	p-value	95% Confidence Limits		VIF
Intercept	-	1.221746	-0.24	0.8132	-2.6846	2.1070	0.157286192
Material Reduct	0.014078	0.160542	0.09	0.9301	-0.3007	0.3289	1.518512876
Energy Reduct	-	0.176666	-0.86	0.3908	-0.4981	0.1948	1.790560612
Water Reduct	0.126551	0.192459	0.66	0.5109	-0.2509	0.5040	1.862664467
Enviro. Reduct	-	0.150370	-1.18	0.2392	-0.4719	0.1179	1.439675357
Env. Manag Syst	-	0.131680	-0.52	0.6059	-0.3262	0.1903	1.100768611
No Env. Manag	0.000000	-	-	-	-	-	0
kmedian3resear1	1.096476	1.046869	1.05	0.295	-0.9564	3.1493	1.985483027
kmedian3resear2	1.011936	1.025329	0.99	0.3238	-0.9987	3.0226	1.996245104
kmedian3resear3	0.000000	-	-	-	-	-	0
kmedian3expen1	0.339173	0.185139	1.83	0.0671	-0.0239	0.7022	1.009916128
kmedian3expen2	-	0.279664	-0.12	0.906	-0.5815	0.5154	1.007092433
kmedian3expen3	0.000000	-	-	-	-	-	0
National	0.556508	0.297089	1.87	0.0612	-0.0261	1.1391	3.852346588
Forange	0.111028	0.324846	0.34	0.7325	-0.5260	0.7480	3.803209611
Nat and Fog	0.000000	-	-	-	-	-	0
cnae 10	0.247985	0.616615	0.4	0.6876	-0.9612	1.4571	1.059149934
cnae 11	0.655631	0.755796	0.87	0.3858	-0.8265	2.1377	1.021957354
cnae 12	7.384658	3.145874	2.35	0.019	1.2157	13.5536	1.000944117
cnae 13	-	0.662873	-0.8	0.4241	-1.8298	0.7699	1.037200162
cnae 14	0.202022	0.675375	0.3	0.7649	-1.1224	1.5264	1.033939471
cnae 15	-	0.694464	-0.12	0.905	-1.4447	1.2789	1.030441061
cnae 16	-	0.798612	-0.81	0.4164	-2.2152	0.9169	1.018631363
cnae 17	1.238838	0.699800	1.77	0.0768	-0.1334	2.6111	1.028934498
cnae 18	-	0.826413	-0.58	0.5615	-2.1004	1.1407	1.016583706
cnae 20	0.609150	0.637752	0.96	0.3396	-0.6415	1.8598	1.046528011
cnae 21	0.124799	0.717344	0.17	0.8619	-1.2819	1.5315	1.02733505
cnae 22	-	0.643282	-0.05	0.9629	-1.2914	1.2315	1.04324195
cnae 23	0.650762	0.661302	0.98	0.3252	-0.6460	1.9475	1.037481492
cnae 24	0.240752	0.700256	0.34	0.731	-1.1324	1.6139	1.028964907
cnae 25	-	0.639977	-0.18	0.8606	-1.3674	1.1426	1.044608459
cnae 26	0.126950	0.674734	0.19	0.8508	-1.1962	1.4501	1.034369495
cnae 27	-	0.658933	-0.46	0.6424	-1.5982	0.9861	1.03788893
cnae 28	0.274548	0.624427	0.44	0.6602	-0.9499	1.4990	1.052991916
cnae 29	-	0.665321	-0.74	0.4617	-1.7945	0.8149	1.037767233
cnae 30	-	0.829900	-0.26	0.7935	-1.8446	1.4102	1.016778286
cnae 31	0.597393	0.664643	0.9	0.3688	-0.7059	1.9007	1.03672228
cnae 32	-	0.695650	-0.32	0.7483	-1.5874	1.1409	1.029916501
cnae 33	0.000000	-	-	-	-	-	0
New revenue 1	-	0.002748	-0.29	0.7714	-0.0062	0.0046	1.232030467
New revenue 2	-	0.004501	-0.49	0.6258	-0.0110	0.0066	1.303292945
New revenue 3	0.016293	0.010936	1.49	0.1364	-0.0052	0.0377	1.331938951
New export 1	0.002352	0.004404	0.53	0.5934	-0.0063	0.0110	1.219317056
New export 2	0.003457	0.005980	0.58	0.5633	-0.0083	0.0152	1.284282496
New export 3	0.015403	0.016342	0.94	0.346	-0.0166	0.0474	1.334599022

Least Squares Means for Effect					
Effects	**Comparisons**	**Difference**	**95% Confidence Limits**		**p-value**
cnae42	**(10 - 12)**	-7.136673	-13.205201	-1.068146	0.0212
	(10 - 13)	0.777955	0.125421	1.430488	0.0195
	(10 - 17)	-0.990853	-1.781749	-0.199956	0.0141
	(10 - 29)	0.737796	0.069105	1.406488	0.0306
	(11 - 12)	-6.729027	-12.858295	-0.59976	0.0314
	(11 - 13)	1.185601	0.109115	2.262087	0.0309
	(11 - 29)	1.145442	0.056132	2.234752	0.0393
	(12 - 14)	7.182636	1.086349	13.278923	0.021
	(12 - 15)	7.467527	1.365037	13.570017	0.0165
	(12 - 16)	8.033828	1.882137	14.18552	0.0105
	(12 - 18)	7.86454	1.700332	14.028749	0.0124
	(12 - 20)	6.775509	0.699896	12.851121	0.0288
	(12 - 21)	7.259859	1.151382	13.368336	0.0199
	(12 - 22)	7.414597	1.335601	13.493593	0.0168
	(12 - 23)	6.733896	0.647879	12.819914	0.0301
	(12 - 24)	7.143906	1.041982	13.245831	0.0218
	(12 - 25)	7.497052	1.419114	13.57499	0.0156
	(12 - 26)	7.257708	1.16431	13.351106	0.0196
	(12 - 27)	7.690712	1.605812	13.775613	0.0133
	(12 - 28)	7.11011	1.038474	13.181745	0.0217
	(12 - 29)	7.874469	1.788726	13.960213	0.0112
	(12 - 30)	7.601879	1.437428	13.766331	0.0157
	(12 - 31)	6.787266	0.696896	12.877635	0.029
	(12 - 32)	7.607929	1.504008	13.711851	0.0146
	(12 - 33)	7.384658	1.21573	13.553587	0.019
	(13 - 17)	-1.768808	-2.692339	-0.845276	0.0002
	(13 - 20)	-1.13912	-1.869035	-0.409204	0.0022
	(13 - 23)	-1.180732	-1.983246	-0.378217	0.0039
	(13 - 31)	-1.127363	-1.939961	-0.314764	0.0066
	(14 - 17)	-1.036815	-1.997717	-0.075914	0.0345
	(15 - 17)	-1.321706	-2.330563	-0.312849	0.0103
	(16 - 17)	-1.888008	-3.156667	-0.619349	0.0036
	(16 - 20)	-1.25832	-2.400505	-0.116135	0.0308
	(16 - 23)	-1.299932	-2.488487	-0.111378	0.0321
	(16 - 31)	-1.246563	-2.437472	-0.055654	0.0402
	(17 - 18)	1.71872	0.379981	3.057459	0.0119
	(17 - 21)	1.114039	0.045568	2.182509	0.041
	(17 - 22)	1.268776	0.398405	2.139147	0.0043
	(17 - 25)	1.351231	0.490025	2.212438	0.0021
	(17 - 27)	1.544892	0.629701	2.460083	0.0009
	(17 - 29)	1.728649	0.798309	2.658989	0.0003
	(17 - 32)	1.462109	0.445308	2.47891	0.0048
	(20 - 25)	0.721543	0.069214	1.373873	0.0302
	(20 - 27)	0.915204	0.19639	1.634018	0.0126
	(20 - 29)	1.098961	0.370862	1.827059	0.0031
	(23 - 25)	0.763156	0.030379	1.495932	0.0412
	(23 - 27)	0.956816	0.158056	1.755577	0.0189
	(23 - 29)	1.140573	0.326289	1.954857	0.0061
	(28 - 29)	0.76436	0.07431	1.454409	0.0299
	(29 - 31)	-1.087204	-1.917842	-0.256565	0.0103
Control	**(1 - 2)**	0.445481	0.097499	0.793462	0.0121

Variance Analisys PART C – SFP

Parameter	Estimate	Standard	t Value	p-	95% Confidence		VIF
Intercept	0.642928	0.606062	1.06	0.2889	-0.5455	1.8314	5.883766432
Material Reduct	0.003265	0.077419	0.04	0.9664	-0.1486	0.1551	0.65584325
Energy Reduct	-0.115882	0.085124	-1.36	0.1735	-0.2828	0.0510	0.557277309
Water Reduct	0.063928	0.092738	0.69	0.4907	-0.1179	0.2458	0.535305893
Enviro. Reduct	-0.079521	0.072476	-1.1	0.2727	-0.2216	0.0626	0.693592692
Env. Manag Syst	0.012658	0.063367	0.2	0.8417	-0.1116	0.1369	0.909473842
No Env. Manag	0.000000	-	-	-	-	-	0
kmedian3resear1	0.380637	0.525814	0.72	0.4692	-0.6505	1.4117	0.492693297
kmedian3resear2	0.375730	0.516019	0.73	0.4666	-0.6362	1.3876	0.490205925
kmedian3resear3	0.000000	-	-	-	-	-	0
kmedian3expen1	0.137698	0.088898	1.55	0.1215	-0.0366	0.3120	0.989724498
kmedian3expen2	0.097290	0.136022	0.72	0.4745	-0.1694	0.3640	0.992810606
kmedian3expen3	0.000000	-	-	-	-	-	0
National	0.293752	0.144257	2.04	0.0418	0.0109	0.5766	0.257641885
Forange	0.085043	0.157802	0.54	0.59	-0.2244	0.3945	0.260761862
Nat and Fog	0.000000	-	-	-	-	-	0
cnae 10	0.036852	0.294392	0.13	0.9004	-0.5404	0.6141	0.944395886
cnae 11	0.510750	0.362243	1.41	0.1587	-0.1996	1.2211	0.97883068
cnae 12	4.033911	1.080479	3.73	0.0002	1.9151	6.1527	0.998263712
cnae 13	-0.183030	0.317583	-0.58	0.5645	-0.8058	0.4397	0.96473186
cnae 14	0.014167	0.322326	0.04	0.9649	-0.6179	0.6462	0.96718687
cnae 15	-0.152699	0.331446	-0.46	0.6451	-0.8027	0.4973	0.970465941
cnae 16	-0.196293	0.381217	-0.51	0.6067	-0.9439	0.5513	0.981702274
cnae 17	0.444784	0.333971	1.33	0.1831	-0.2101	1.0997	0.9718887
cnae 18	-0.424405	0.394403	-1.08	0.282	-1.1978	0.3490	0.983688334
cnae 20	0.250143	0.304663	0.82	0.4117	-0.3473	0.8476	0.95584984
cnae 21	-0.170052	0.343271	-0.5	0.6204	-0.8432	0.5031	0.973631005
cnae 22	0.196974	0.308411	0.64	0.5231	-0.4078	0.8018	0.959566157
cnae 23	0.280954	0.315610	0.89	0.3735	-0.3379	0.8999	0.963888615
cnae 24	0.267066	0.335539	0.8	0.4262	-0.3909	0.9251	0.972303075
cnae 25	-0.057436	0.306083	-0.19	0.8512	-0.6577	0.5428	0.957830694
cnae 26	0.038672	0.323603	0.12	0.9049	-0.5959	0.6732	0.967466675
cnae 27	-0.127340	0.315480	-0.4	0.6865	-0.7460	0.4913	0.96408838
cnae 28	0.164770	0.298071	0.55	0.5805	-0.4197	0.7493	0.949854264
cnae 29	-0.001481	0.318146	0	0.9963	-0.6254	0.6224	0.964088039
cnae 30	-0.144548	0.396174	-0.36	0.7152	-0.9214	0.6323	0.983488026
cnae 31	0.285703	0.318033	0.9	0.3691	-0.3380	0.9094	0.965056604
cnae 32	-0.250833	0.331988	-0.76	0.45	-0.9019	0.4002	0.970963013
cnae 33	0.000000	-	-	-	-	-	0
New revenue 1	0.000461	0.001327	0.35	0.7285	-0.0021	0.0031	0.809087615
New revenue 2	-0.002502	0.002159	-1.16	0.2466	-0.0067	0.0017	0.765639631
New revenue 3	0.011668	0.004938	2.36	0.0182	0.0020	0.0213	0.77047314
New export 1	-0.000320	0.002113	-0.15	0.8797	-0.0045	0.0038	0.817177541
New export 2	-0.000389	0.002858	-0.14	0.8917	-0.0060	0.0052	0.776992409
New export 3	0.005667	0.007723	0.73	0.4631	-0.0095	0.0208	0.764216007

Least Squares Means for Effect

Effects	Comparisons	Difference Between Means	95% Confidence Limits		p-value
cnae42	**(10 - 11)**	-0.473898	-0.939646	-0.008151	0.0461
	(10 - 12)	-3.997059	-6.048819	-1.945299	0.0001
	(10 - 17)	-0.407932	-0.785717	-0.030148	0.0343
	(11 - 12)	-3.523161	-5.616362	-1.429959	0.001

(11 - 13)	0.69378	0.173157	1.214403	0.009
(11 - 15)	0.66345	0.109763	1.217137	0.0189
(11 - 16)	0.707044	0.04118	1.372908	0.0374
(11 - 18)	0.935156	0.240412	1.6299	0.0084
(11 - 21)	0.680803	0.099174	1.262432	0.0218
(11 - 25)	0.568186	0.072147	1.064225	0.0248
(11 - 27)	0.63809	0.118362	1.157819	0.0161
(11 - 32)	0.761584	0.205742	1.317425	0.0073
(12 - 13)	4.216941	2.151524	6.282358	<.0001
(12 - 14)	4.019744	1.950393	6.089094	0.0001
(12 - 15)	4.186611	2.111733	6.261488	<.0001
(12 - 16)	4.230204	2.122516	6.337893	<.0001
(12 - 17)	3.589127	1.515271	5.662982	0.0007
(12 - 18)	4.458316	2.342206	6.574427	<.0001
(12 - 20)	3.783768	1.727279	5.840257	0.0003
(12 - 21)	4.203964	2.125195	6.282732	<.0001
(12 - 22)	3.836937	1.77746	5.896414	0.0003
(12 - 23)	3.752957	1.689276	5.816639	0.0004
(12 - 24)	3.766845	1.691629	5.842061	0.0004
(12 - 25)	4.091347	2.032796	6.149898	<.0001
(12 - 26)	3.99524	1.927043	6.063436	0.0002
(12 - 27)	4.161251	2.09819	6.224312	<.0001
(12 - 28)	3.869141	1.815863	5.922418	0.0002
(12 - 29)	4.035392	1.971695	6.099089	0.0001
(12 - 30)	4.178459	2.062111	6.294808	0.0001
(12 - 31)	3.748208	1.681703	5.814712	0.0004
(12 - 32)	4.284744	2.210204	6.359284	<.0001
(12 - 33)	4.033911	1.915117	6.152705	0.0002
(13 - 17)	-0.627814	-1.071821	-0.183808	0.0056
(13 - 20)	-0.433173	-0.786708	-0.079638	0.0164
(13 - 22)	-0.380004	-0.744221	-0.015787	0.0409
(13 - 23)	-0.463984	-0.850634	-0.077333	0.0187
(13 - 24)	-0.450096	-0.897272	-0.002921	0.0485
(13 - 28)	-0.3478	-0.679628	-0.015973	0.04
(13 - 31)	-0.468733	-0.862846	-0.074621	0.0198
(15 - 17)	-0.597484	-1.078978	-0.115989	0.015
(15 - 20)	-0.402842	-0.8018	-0.003884	0.0478
(15 - 23)	-0.433653	-0.863038	-0.004269	0.0478
(15 - 31)	-0.438403	-0.874113	-0.002693	0.0486
(16 - 17)	-0.641078	-1.246837	-0.035318	0.0381
(17 - 18)	0.86919	0.23028	1.508099	0.0077
(17 - 21)	0.614837	0.102387	1.127287	0.0187
(17 - 25)	0.50222	0.089405	0.915035	0.0171
(17 - 27)	0.572124	0.132526	1.011723	0.0108
(17 - 29)	0.446265	0.000696	0.891834	0.0496
(17 - 32)	0.695617	0.210343	1.180892	0.005
(18 - 20)	-0.674548	-1.25447	-0.094626	0.0226
(18 - 22)	-0.621379	-1.209028	-0.033731	0.0382
(18 - 23)	-0.705359	-1.30651	-0.104209	0.0215
(18 - 24)	-0.691472	-1.332995	-0.049948	0.0347
(18 - 28)	-0.589176	-1.156804	-0.021547	0.0419
(18 - 31)	-0.710109	-1.316513	-0.103705	0.0217
(20 - 27)	0.377483	0.029714	0.725251	0.0334
(20 - 32)	0.500976	0.097759	0.904193	0.0149
(22 - 32)	0.447807	0.034397	0.861217	0.0338
(23 - 27)	0.408294	0.023729	0.792859	0.0375
(23 - 32)	0.531787	0.098074	0.9655	0.0163

	(24 - 32)	0.517899	0.029449	1.00635	0.0377
	(27 - 31)	-0.413043	-0.804761	-0.021326	0.0388
	(28 - 32)	0.415603	0.033239	0.797968	0.0332
	(31 - 32)	0.536537	0.09802	0.975053	0.0165
Control	**(1 - 2)**	0.208709	0.040198	0.37722	0.0152